Canadian Institute of
Guided Ground Transport
Queen's University
at Kingston, Ontario

prepared for
Transportation Development Centre
and CP Rail

by

S.F. Lamson

CIGGT Report No. 84-14
Transport Canada Report No. 6175E

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CIGGT Project No. PRO-302

CIGGT Report No. 84-14
Transport Canada Report No. TP-6175E

RAIL PROFILE GRINDING

Phase II Test Report

prepared for the

Transportation Development Centre

and

CP Rail

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February 1985

ISBN 0 88911 229 0

This report resulted from research conducted through the Canadian Institute of Guided Ground Transport. The report represents the views of the authors and does not necessarily have the endorsement of the University or the other participating organizations.

REPORT DOCUMENTATION FORM

1. Transport Canada Report No	2. TDC Project No.	3. Recipient's Catalogue No.
TP-6175E	6011	

4. Title and Subtitle	5. Report Date
RAIL PROFILE GRINDING Phase II Test Report	February 1985
	6. Performing Organization Report No. 84-14
7. Author(s) S.T. Lamson	8. Transport Canada File No D-1465-368-3
9. Performing Organization Name and Address Canadian Institute of Guided Ground Transport (CIGGT) Queen's University Kingston, Ontario K7L 3N6	10. DSS File No 11SD.T8200-3-3502
	11. DSS or Transport Canada Contract No. OSD83-00031
12. Sponsoring Agency Name and Address Transportation Development Centre (TDC), Suite 2421 1000 Sherbrooke St.W., Montreal, Quebec H3A 2R3 CP Rail (CP), Windsor Station, P.O. Box 6042 Station A, Montreal, Quebec H3C 3E4	13. Type of Report and Period Covered Final, July/83-Dec./84
	14. Sponsoring Agency Code TDC 6011
15. Supplementary Notes Phase I work is documented in TP-3998E, CIGGT Report No. 82-7, "Rail Profile Grinding," November 1982	16. TDC Project Officer W.G. Rowan

17. Abstract

The second of two field tests involving fifteen test curves to reliably verify the performance of the CIGGT asymmetrical rail grinding pattern is reported. Monitoring these test curves for six months after test grinding has shown that CIGGT's pattern significantly reduced rail corrugation and improved rail surface conditions on the low side. On the high side, this pattern prevented further deterioration in rail surface conditions and produced no measurable wear over a sixteen-week period, during which 18 MGT of traffic passed over the rail. The use of CIGGT's pattern in a modified grinding program involving one grinding pass every four months may have the best potential for significant track maintenance cost savings.

18. Key Words	19. Distribution Statement
Curve; Rail wear; Configuration, Shelling; Rail grinding; Grinding; Rail profile, Plastic flow; Gauge face wear	Limited number of copies available free of charge from TDC and CIGGT. Additional copies may be obtained from CIGGT at nominal cost.

20. Security Classification (of this report)	21. Security Classification (of this page)	22. No of Pages	23. Price
unclassified	unclassified	23 + append.	

TDC CDT 79-005

FORMULE DE DOCUMENTATION POUR RAPPORT

1 N° du rapport Transports Canada	2 N° de l'étude — CDT	3 N° de catalogue du destinataire
TP-6175E	6011	

4 Titre et sous-titre	5 Date du rapport
RAIL PROFILE GRINDING Phase II Test Report	Février 1985
	6 N° du rapport de l'organisme exécutant 84-14
7 Auteur(s)	8 N° de dossier Transports Canada
S.T. Lamson	D-1465-368-3
9 Nom et adresse de l'organisme executant	10 N° de dossier — ASC
Canadian Institute of Guided Ground Transport (CIGGT) Queen's University Kingston, Ontario K7L 3N6	11SD.T8200-3-3502
	11 N° de contrat — ASC ou Transports Canada OSD83-00031
12 Nom et adresse de l'organisme parrain	13 Genre de rapport et période visée
Centre de développement des transports (CDT), 1000 o., rue Sherbrooke, Suite 2421, Montréal, Québec H3A 2R3 CP Rail (CP), Gare Windsor, C.P. 6042, Station A., Montréal, Québec H3C 3E4	Final, juil.83-Déc.84
	14 Code de l'organisme parrain CDT 6011
15 Remarques additionnelles Les travaux concernant la phase I sont présentés dans le rapport "Rail Profile Grinding," TP-3998E, N° 82-7 du CIGGT, novembre 1982.	16 Agent de projet — CDT W.G. Rowan

17 Resume

Ce rapport rend compte des résultats de la deuxième série de contrôles sur le terrain visant à vérifier la tenue des rails à profilage asymétrique réalisé selon le concept imaginé par le CIGGT. Le comportement des quinze tronçons en courbe concernés a été surveillé pendant six mois après leur reprofilage et l'on a constaté une diminution notable de l'usure ondulatoire ainsi qu'une détérioration moindre de l'état de surface du rail intérieur. Quant au rail extérieur, son nouveau profil a empêché une dégradation plus poussée de l'état de surface sans susciter d'usure mesurable sur une période de seize semaines, soit après un trafic de 18 Mt. Le reprofilage asymétrique mis au point par le CIGGT semble donner les meilleurs résultats au chapitre de la réduction des coûts d'entretien de la voie ferrée lorsqu'il est réalisé à quatre mois d'intervalle, en une seule passe.

18 Mots-clés	19 Diffusion
Voie en courbe, usure des rails, profil d'usure, écaillage, meulage des rails, meulage, profil des rails, écoulement plastique, face intérieure	Nombre limité de copies disponibles gratuitement auprés du CDT et CIGGT. D'autres exemplaires peuvent être obtenus du CIGGT à un prix minime.

20 Classification de securite (de ce rapport)	21 Classification de securite (de cette page)	22 Nombre de pages	23 Prix
non-classifié	non classifiée	23 + append.	

CDT TDC 79-005

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EXECUTIVE SUMMARY

The second of two field tests involving fifteen curves was carried out to reliably verify the performance of the CIGGT asymmetrical rail grinding pattern and to explore its possible refinement. These test curves were monitored for six months after the test grinding was carried out. The results indicate that at six months after test grinding:

(a) Both CIGGT and CN grinding patterns for low rails produced a corrugation level significantly lower than that at pre-grinding. Relatively, the CIGGT pattern produced better results.

(b) Both CIGGT and CN grinding patterns produced rail surface conditions noticeably better than that at pre-grinding. Relatively, the CN pattern produced better results. The CIGGT pattern for low rails can be further refined with extra grinding of the field corner to achieve the CN result for rail surface conditions and reduce the formation of the flow lip.

(c) Both CIGGT and CN grinding patterns for high rails prevented further deterioration in rail surface conditions (e.g. shelling and spalling). Relatively, the CN pattern produced better results. The CIGGT pattern for high rails can be further refined with two extra grinding wheels on the gauge corner to achieve the CN result for rail surface conditions.

(d) Gauge corner grinding can be from as little as in the CP Research pattern, to as much as in the CN pattern, without significant effect on rail wear.

(e) In track locations where a grinding program of two grinding passes every six months is applied, an alternative grinding program of one grinding pass every four months would appear to be more efficient and provide more benefit to track maintenance.

Based on the results of the test, the following recommendations are offered:

(a) Employ the CIGGT grinding pattern (#0 for high rails and #1 for low rails) in all curved track grinding.

(b) Investigate the potential benefit of changing the present rail grinding schedule to every four months, with the grinding train proceeding from one end of the track to the other without back-tracking.

SOMMAIRE ADMINISTRATIF

Cette deuxième série de contrôles sur le terrain visait quinze tronçons en courbe et avait pour but de vérifier la tenue des rails reprofilés selon la technique mise au point par le CIGGT, et possiblement d'affiner celle-ci. Le comportement des voies en courbe visées a été suivi pendant une période de six mois après le reprofilage asymétrique des rails. Voici les résultats constatés au bout de cette période:

(a) L'usure ondulatoire a considérablement baissé sur les rails intérieurs à profil CIGGT ainsi que sur ceux à profil CN, l'avantage allant cependant au profil CIGGT.

(b) Les deux techniques de reprofilage, celle du CIGGT et celle du CN, ont entraîné une amélioration notable de l'état de surface des rails, l'avantage allant cette fois à la technique CN. Le profil CIGGT pourrait être perfectionné en ce qui concerne les rails intérieurs par un meulage plus accentué du coin extérieur, visant à égaler l'état de surface obtenu par la méthode CN et à atténuer le phénomène d'écoulement plastique.

(c) Les deux techniques de reprofilage CIGGT et CN, ont empêché l'aggravation des avaries de surface sur le rail extérieur (écaillage, exfoliation), la technique CN donnant les meilleurs résultats. Celle du CIGGT pourrait être perfectionnée en adjoutant deux meules pour le coin intérieur des rails extérieurs.

(d) Le meulage du coin intérieur des rails au profil CP, au profil CN ou à tout profil intermédiaire ne change pas beaucoup le mode d'usure des rails.

(e) Un programme de meulage prévoyant le reprofilage en une seule passe à intervalle de 4 mois semble donner de meilleurs résultats qu'un reprofilage en deux passes à tous les six moi.

A la lumière des résultats obtenus, il est recommandé de:

(a) reprofiler toutes les voies en courbe selon la technique du CIGGT (réglage 0 pour la file extérieure et 1 pour la file intérieure);

(b) déterminer les avantages potentiels du meulage des rails en une seule passe à quatre mois d'intervalle, le train meuleur ne revenant jamais en arrière, par opposition au programme actuel qui prévoit un reprofilage aux six mois et en deux phases.

1. INTRODUCTION

Heavy-haul railway operation generally offers an overall economic advantage, but only at the expense of high maintenance requirements and costs, particularly for rails.

CP Rail operates, among many other services, a heavy-axle-load coal unit train operation betwen Golden and Roberts Bank in British Columbia. Over the 450-mile stretch of track, the railway hauls about 55 MGT (50 mmgt) a year.

Rail maintenance problems have been very severe, as the pressure of heavy-haul operation is compounded by unfavourable track conditions in the very difficult terrain of the Rocky Mountain Range.

In 1982, an initial field grinding test program[1] was conducted in this territory. The general aim was to adapt the rail profile grinding technique which had been used successfully to reduce rail wear in Australian heavy-haul railways to improve the life of rail in CP curved track. Based on the nature of the rail deterioration problems, the following specific objectives were established (listed in order of priority):

(a) reduction of corrugation, which occurs mainly on low rails

(b) reduction of gauge-corner shelling, which occurs mainly on high rails

(c) reduction of gauge-side wear, which occurs mainly on high rails.

Three curves (2°, 4° and 8°) were selected for the test. These were monitored for a period of six months. The test resulted in the following tentative conclusions:

(a) Grinding of the field side of low rail surfaces is effective in reducing corrugation.

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1 Lamson, S.T. Rail Profile Grinding. CIGGT Report No. 82-7, November 1982

(b) Grinding of the gauge corner of high rails is effective in reducing shelling.

(c) Too much gauge-corner grinding can cause an increase in lateral wheel forces.

Based on these conclusions, a design for a ground rail profile was recommended for provisional application. A second field test involving a larger number of test curves was considered necessary to reliably verify the performance of this profile design prior to its full implementation.

This report describes this second field test, which began in May 1984 on the Cascade Subdivison of CP's western main line.

2. DESCRIPTION OF FIELD TEST

2.1 Objectives

The primary objectives of this test were to:

- reliably verify the performance of the CIGGT-proposed ground rail profile
- explore its possible refinements.

The performance to be verified included:

- the effect of rail grinding on the rate of regrowth of corrugation on low rails
- the effect of rail grinding on the rate of gauge face wear and surface fatigue shelling on high rails.

2.2 Test Design Concept

To fulfill the objective of reliable verification in a practical environment with its usual resource constraints, the following criteria were employed:

- a sufficiently large number of test curves were to be monitored

- rail performance was to be measured directly
- the monitoring period was to be sufficiently long.

In addition, to ensure that whatever was achieved in the test could also be achieved in actual track application, the number of grinding passes used during the test was kept the same as the typical number of grinding passes used in practice. As CP carries out grinding approximately every six months, the condition of rails in the test curves was monitored over the same period.

2.3 Test Grinding Pattern

Six grinding patterns were tested. Details are as follows:

- Pattern #0 is a CIGGT design for high rails.
- Pattern #1 is a CIGGT design for low rails.
- Patterns #3, #5 and #6 are CN designs for rails in concrete-tie curved track. Patterns #3 and #5 are used in combination (one grinding pass each) for high rails, while #3 and #6 are used for low rails. Compared to the CIGGT patterns, these produce a sharper cut on the field and gauge sides. These patterns were available on the grinding train and were used as convenient alternatives for comparative testing. They may not perform as designed because the CP test curves have timber ties (dynamic gauge widening may be larger).
- Pattern #4 is a modified version of the CIGGT design for high rails. The modification was recommended by CP Research. It entails a restoration of the gauge corner to its original contour (i.e. the shelled surface is ground down but the contour remains unchanged).

For comparison, a schematic sketch of the designed rail profiles producible with these grinding patterns is shown in Figure 1. Details of the grinding wheel angles for each of the above described patterns are shown in Table 1.

TABLE 1

RAIL GRINDING ANGLE SETTINGS USED IN FIELD TEST MAY 1984*

Motor Pairs	Pattern 0	1	3	4	5	6	Buggy Type
1-3	+1	+1	-3	+1	-17	-18	Gauge
5-7	+1	+1	-3	+1	-21	-21	Gauge
9-11	+1	+1	0	+1	+14	+9	Centre
13-15	-2	+3	0	-2	+14	+12	Centre
17-19	+3	+3	+3	+3	+18	+15	Field
21-23	+3	0	+3	+3	+18	+12	Field
25-27	-8	-6	-5	-5	-24	-24	Gauge
29-31	-22	-10	-5	-3	-24	-24	Gauge
33-35	+5	+7	-2	-22	+21	+21	Centre
37-39	-27	-1	-2	+5	+21	+21	Centre
41-43	-4	-4	+2	+7	+24	+24	Field
45-47	0	+21	+3	0	+24	+24	Field
49-51	+11	-1	+3	+11	+24	+24	Centre
53-55	-29	-5	+2	-13	-26	-26	Centre
57-59	+21	-12	0	+21	-26	-26	Centre
61-63	-24	-3	-7	+26	-26	-26	Centre
65-67	-17	-8	-7	-6	-26	-26	Centre
69-71	+26	-3	-5	0	+24	+24	Centre
73-75	-3	+26	+3	-3	+24	+24	Field
77-79	+7	+16	+3	+5	+24	+24	Field
81-83	+5	+7	0	+5	+21	+21	Centre
85-87	+5	-1	0	+3	+21	+21	Centre
89-91	-33	0	-3	-33	-24	-24	Gauge
92-95	-12	-1	-3	-6	-24	-24	Gauge
97-99	+3	-1	+2	+3	+18	+15	Field
101-103	+3	0	+2	+1	+18	+15	Field
105-107	-5	0	-2	-8	-14	+12	Centre
109-111	+3	0	-2	-5	-17	+9	Centre
113-115	+1	+1	-5	+1	-21	-21	Gauge
117-119	+1	+1	-5	-2	-17	-18	Gauge

Pattern 0: CIGGT pattern for high rails
1: CIGGT pattern for low rails
3: CN top-of-rail pattern
4: CP Research pattern for high rails
5: CN low rail profile pattern
6: CN high rail profile pattern

* All angles shown are in degree measured relative to grinding vehicle frame of refernece and with the CP 1-in-20 rail cant taken into account.

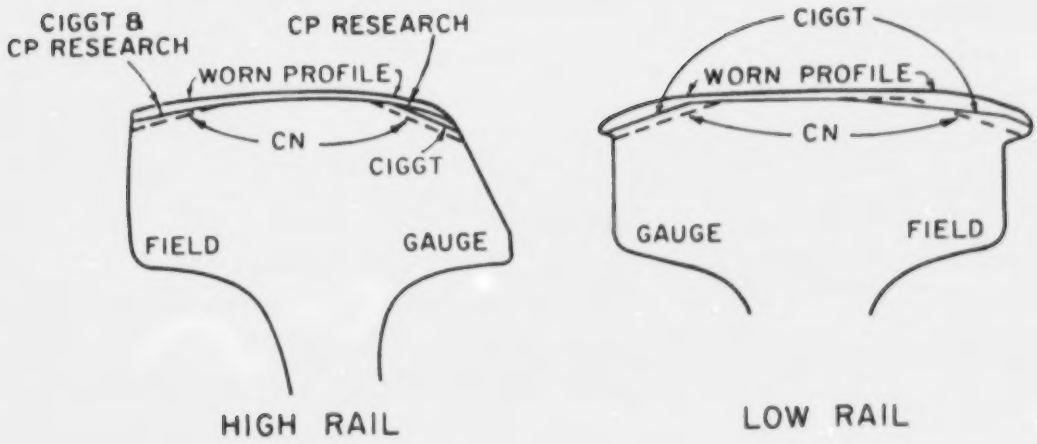

Figure 1 Conceptual differences between CP Research, CIGGT and CN grinding patterns

2.4 Test Curves

Of all 4° and 8° curves inspected between China Bar (MP 6) and Yale (MP 29) on the CP Cascade subdivision, 22 curves were found to have adequate corrugation and/or shelling for the test. Of these, 15 curves were finally selected for test grinding. The selection was made according to the following criteria for each of the 4° and 8° groups:

(a) Rails were of similar laying date and same metallurgy (all were Algoma chrome)

(b) Degrees of curvature, measured at mid-curve, were comparable within the group, and for the group as a whole were close to the nominal degree (i.e. 4° or 8°)

(c) For the comparison of CIGGT and CP Research patterns for high rails, two adjacent curves were used whenever possible to enable accurate comparison of performance, since the difference between the two profiles is small.

(d) For the comparison of CIGGT and CN patterns for corrugated low rails, curves with comparable initial corrugation levels were used whenever possible.

(e) To ensure a fair comparison, all curves received two grinding passes at 2 mph. Thus, if any difference in rail performance was recorded later, it could be attributed to the profile and not the level of grinding effort.

Figure 2 shows the location of the test curves on the track chart. Each curve was given an ID number.

The following comparison was set up:

(a) Comparison of high rail performance:

- for 8° curve group:
  - CIGGT pattern: Curves #14, #20
  - CP Research pattern: Curves #11, #19
  - CN Rail pattern: Curves #10, #13

- for 4° curve group:
  - CIGGT pattern: Curves #01, #21
  - CP Research pattern: Curves #17, #22
  - CN Rail pattern: Curves #09, #12

(b) Comparison of low rail performance:

- for 8° curve group:
  - CIGGT pattern: Curves #11, #14, #20
  - CN Rail pattern: Curves #10, #13, #19

- for 4° curve group:
  - CIGGT pattern: Curves #01, #12, #21
  - CN Rail pattern: Curves #09, #17, #22

In addition, curves #3, #5 and #8 were also ground to provide additional data. Details of the test grinding are shown in Table 2.

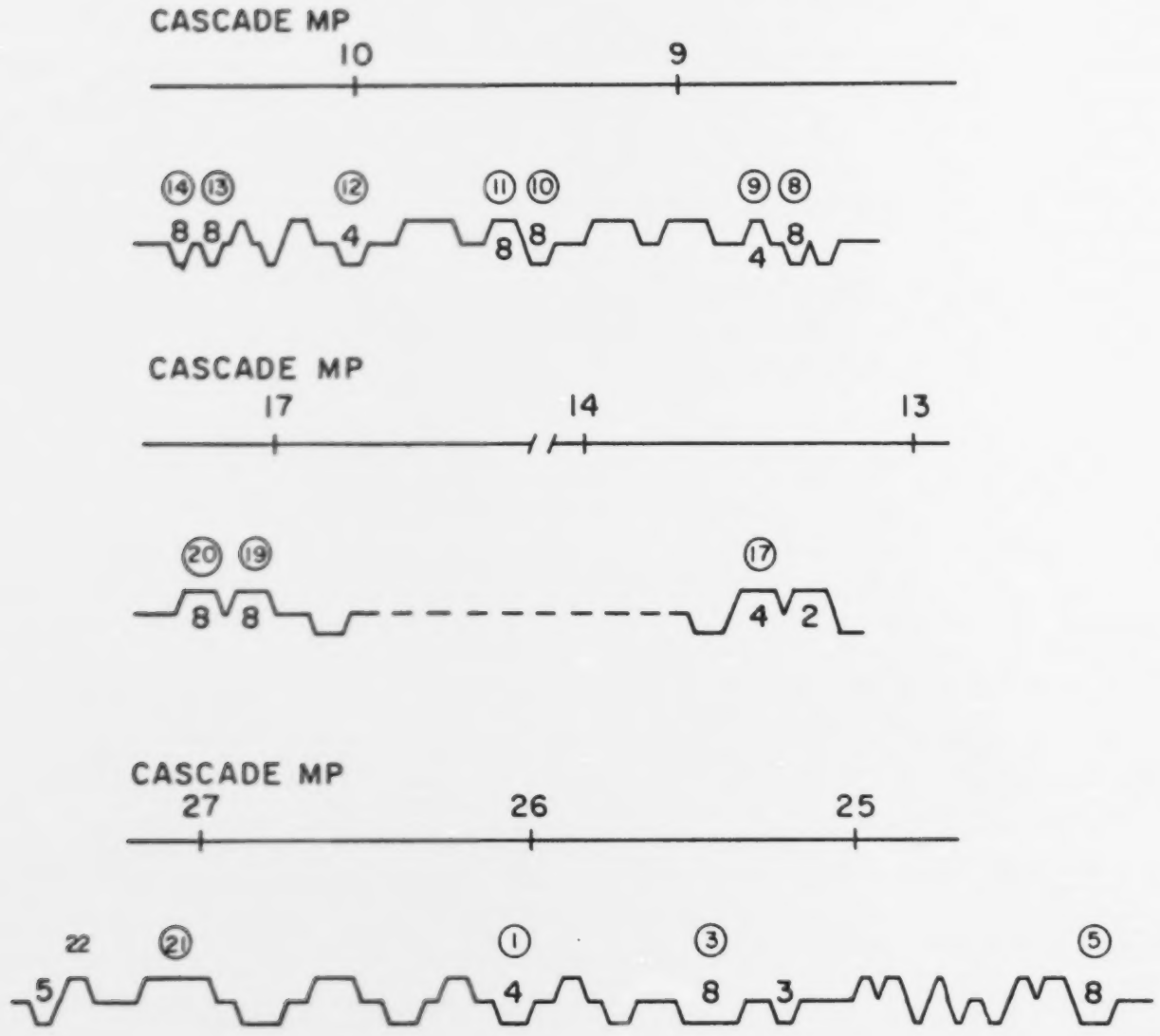

Figure 2 Location of test curves

TABLE 2

TEST GRINDING DETAILS

Curve Number and Location	Degree of Curvature	Rail Grinding Details					
		Rail Profile Type*		1st Pass Pattern No.		2nd Pass Pattern No.	
		High Rail	Low Rail	High Rail	Low Rail	High Rail	Low Rail
1, MP 26.0	4	CIG	CIG	0	1	0	1
3, MP 25.5†	8	CIG	CIG	0	1	0	1
5, MP 24.3†	8	CPR	CN	4	3	4	5
8, MP 8.5	8	CN	CIG	3	1	6	1
9, MP 8.9	4	CN	CN	3	3	6	5
10, MP 9.5	8	CN	CN	3	3	6	5
11, MP 9.6	8	CPR	CIG	4	1	4	1
12, MP 10.0	4	CN	CIG	3	1	6	1
13, MP 10.5	8	CN	CN	3	3	6	5
14, MP 10.6	8	CIG	CIG	0	1	0	1
17, MP 13.5	4	CPR	CN	4	3	4	5
19, MP 17.2	8	CPR	CN	4	3	4	5
20, MP 17.1	8	CIG	CIG	0	1	0	1
21, MP 27.0	4	CIG	CIG	0	0	0	0
22, MP 27.3	4	CPR	CN	4	3	4	5

* Pattern 0: CIGGT pattern for high rails
1: CIGGT pattern for low rails
3: CN top-of-rail pattern
4: CP Research pattern for high rails
5: CN low rail profile pattern
6: CN high rail profile pattern

† These are additional curves that do not received f[illegible] measurement

2.5 Test Monitoring and Data Collection

2.5.1 Corrugation

The corrugation level in each test curve was measured at forty locations, each of which was identified by a tie number. At each location, corrugation depth was recorded using a 24" straight edge and a taper gauge. The gauge has 0.001" resolution and can detect corrugation down to 0.005". Proper reading, however, starts at 0.010" and any detectable corrugation below 0.010" is estimated to be 0.005".

The measurement was carried out five times during the testing and monitoring period, according to the following schedule:

- two weeks before test grinding
- two weeks after test grinding (to allow for rehardening of the rail surface after grinding)
- three months after test grinding
- four months after test grinding
- six months after test grinding.

2.5.2 Shelling and Spalling

The surface shelling and plastic flow problems on high and low rails were inspected and recorded with photographs. One set of high and low rail photographs was taken at the same location in each curve each time to permit a visual observation of the progressive change in rail surface conditions. The timing for this monitoring was the same as for corrugation.

2.5.3 Wear

The change in rail profile due to grinding and wear, especially gauge face wear on high rails, was recorded with a CP Research-designed Rail Profilometer. Complete rail head profiles for high and low rails at three locations in each test curve were recorded. In all, the measurements were taken as follows:

- three weeks prior to test grinding
- one week after test grinding
- ten weeks after test grinding
- sixteen weeks after test grinding

3. RESULTS

3.1 Corrugation

Figures 3 through 8 describe the average[2] corrugation regrowth pattern in each test curve from the time of the test grinding to six months thereafter. Details of corrugation regrowth at each measurement location in each test curve are shown in Figures A.1 through A.13 in Appendix A. For clarity, these figures only include measurements at pregrinding, at four months and at six months.

Figures 3 through 8 each show a CIGGT/CN pair of test curves. The groupings represent the best possible match, within practical constraints, for a one-to-one comparison of corrugation control performance. From each graph, the following comparisons can be made:

(a) Regrowth rate: defined as the increase in corrugation depth from the level at two weeks after grinding.

(b) Absolute reduction: defined as the difference between the corrugation depth at six months after grinding and that prior to grinding. The CP grinding program is carried out approximately every six months. If a regular CP grinding pattern had been used during the test, instead of the CIGGT or CN patterns, the corrugation level at six months could be the same as the level measured before test grinding.[3] This relationship can be visualized in Figure 9.

The absolute reduction concept is intended only to provide the reader with an approximate method of drawing practical, useful conclusions as to the effect of profile grinding on corrugation growth. There are a number of unknown factors which may affect the validity of this concept. For example, it is not known precisely what the "regular CP grinding" pattern is, nor are the effects of climatic changes on the

2 The calculation of average corrugation excludes locations where a battered weld created unusually deep corrugation. This exclusion has been found not to affect the outcome of the comparative analysis.

3 The actual date for the "sixth month" measurement was in fact selected to ensure approximately the same tonnage as between the test grinding and the previous grinding.

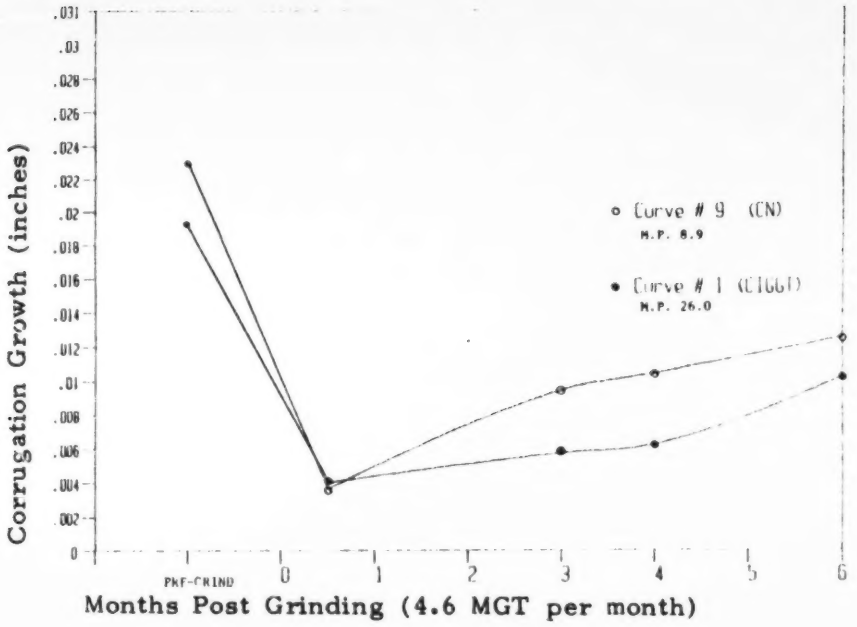

Figure 3 Overall Corrugation Regrowth Rate, Curve 9 (CN) versus Curve 1 (CIGGT)

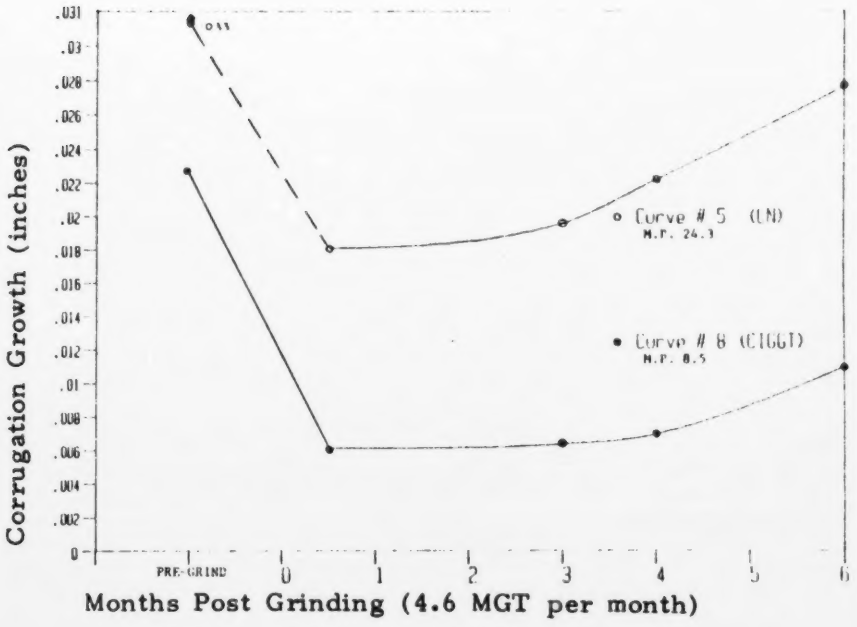

Figure 4 Overall Corrugation Regrowth Rate, Curve 5 (CN) versus Curve 8 (CIGGT)

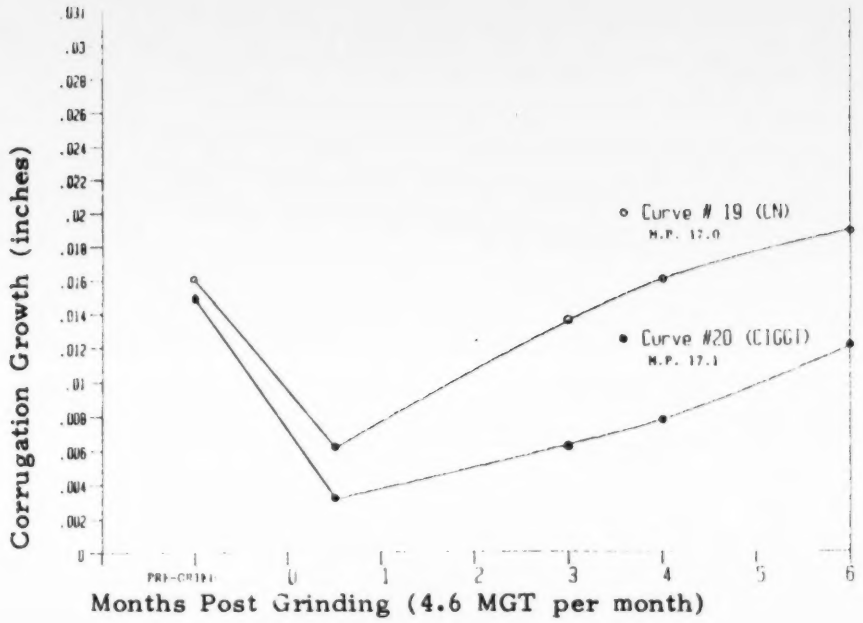

Figure 5 Overall Corrugation Regrowth Rate, Curve 19 (CN) versus Curve 20 (CIGGT)

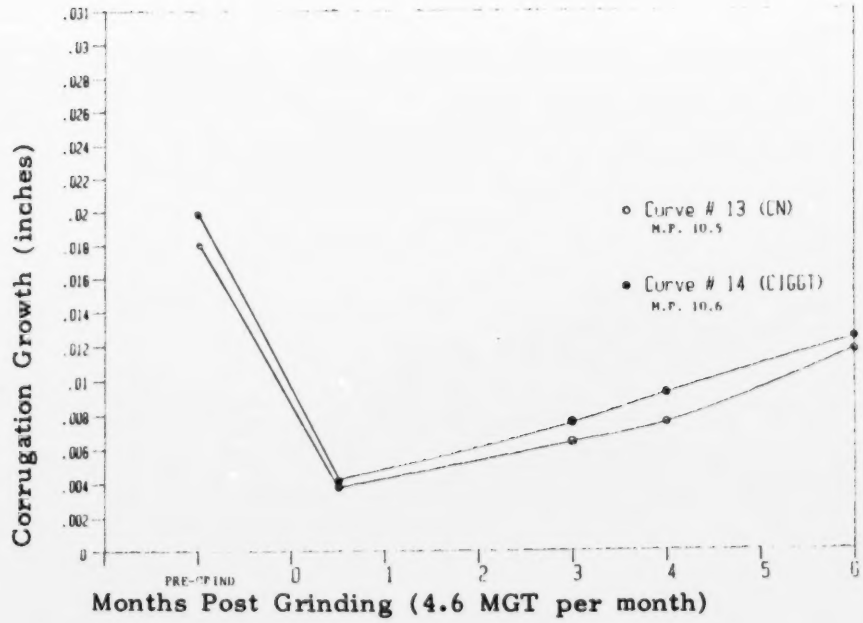

Figure 6 Overall Corrugation Regrowth Rate, Curve 13 (CN) versus Curve 14 (CIGGT)

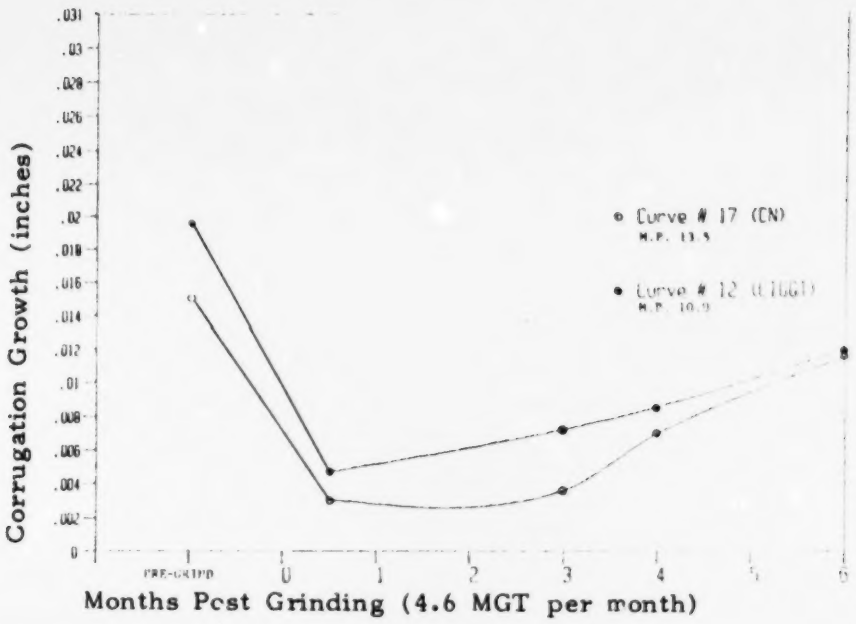

Figure 7 Overall Corrugation Regrowth Rate, Curve 17 (CN) versus Curve 12 (CIGGT)

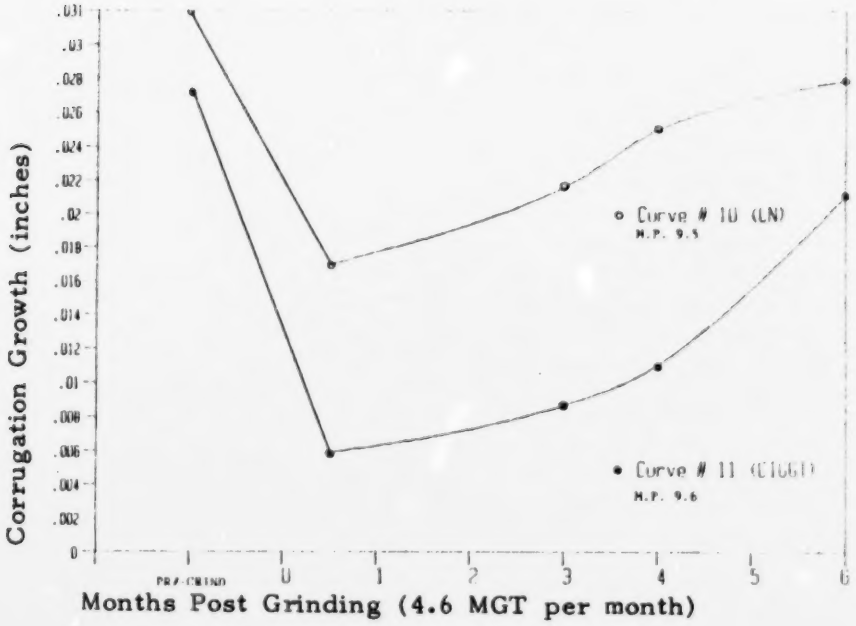

Figure 8 Overall Corrugation Regrowth Rate, Curve 10 (CN) versus Curve 11 (CIGGT)

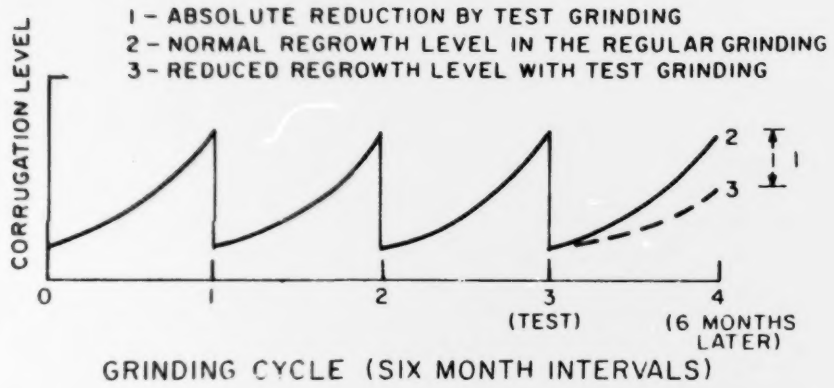

Figure 9 Concept of absolute reduction of corrugation regrowth

corrugation growth rate known. (The grinding cycles alternate from fall/winter to spring/summer.) An exact conclusion, therefore, requires either a laborious test or seveal years of observation. Both options are impactical for the present situation.

The data in Figures 3 through 8 lead to the following overall observations:

(a) In terms of lower corrugation regrowth rate, the CIGGT pattern was better than the CN pattern in four cases; approximately equal in one case (Figure 6); and worse in one case (Figure 8). In the "worse" case, the CIGGT test curve was subject to severe mud pumping due to fouled ballast and drainage problems.

(b) In terms of larger absolute corrugation reduction, the CIGGT pattern was better than the CN pattern in four cases, and approximately equal in two cases (Figures 3 and 6). In one of the test curves, the CN pattern actually caused an increase in the corrugation level (Figure 5).

The above results are summarized in Figure 10, which represents the average for all CIGGT and CN test curves. (The odd curve, #13, ground with the CIGGT pattern, is also included.) It is evident that, overall, both CIGGT and CN grinding patterns are effective in reducing corrugation. However, the CIGGT pattern produced relatively better results.

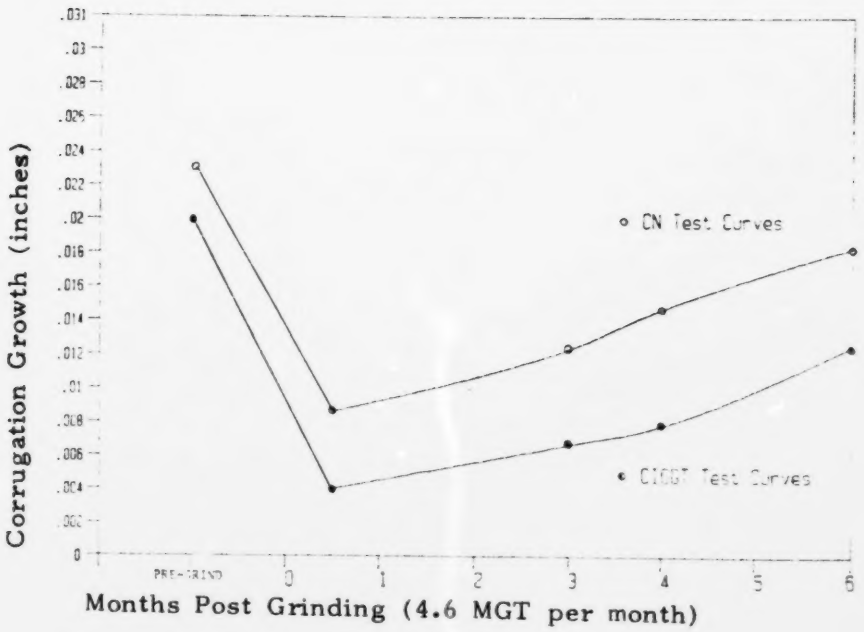

Figure 10 Average corrugation regrowth, all curves

3.2 Shelling and Spalling

Photographs of the high and low rail surface conditions are shown in Appendix B, Figures B.1 through B.60. Figures B.1 through B.15 represent conditions prior to test grinding. Others represent conditions after test grinding, with B.16 through B.30 at two weeks after; B.31 through B.45 at three months after; and B.46 through B.60 at six months after.

These photographs were evaluated qualitatively and subjectively for surface cracks, shelling and flow problems by a panel of five members of the steering committee.[4] A rating scale of 1 through 7 was used. One indicates the rail surface condition is visibly worse; 4 indicates no change; and 7 indicates visibly better. Each member gave his rating independently.

Table 3 shows the ratings for comparison of the surface conditions at three months after grinding versus pregrinding. As in the case of corrugation evaluation (refer to Figure 9), the condition at pregrinding

4 W. Liddell (CP), M. Roney (CP), R. Gonsalves (CP Research), A. Zarembski (Speno), and S. Lamson (CIGGT). The other committee member, Mr. W. Rowan (TDC), was not present.

is also the expected condition at six months after grinding, had regular instead of test grinding been carried out. These ratings show that, at the three-month mark, all rail surface improvements achieved by grinding were well retained. In particular:

(a) For high rails: The CIGGT pattern provided visibly the most improvement in rail surface conditions (average rating: 6.75); followed by the CN pattern (average rating: 6.13). The CP Research pattern provided the least relative improvement (average rating: 5.45).

(b) For low rails: Both the CIGGT and CN patterns provided visibly better rail surfaces. The CN pattern was, however, slightly better (average rating: 5.93 versus 5.80).

TABLE 3

RELATIVE RATING OF RAIL SURFACE CONDITIONS
PREGRINDING VERSUS THREE MONTHS AFTER GRINDING

Curve No.	High Rail			Low Rail	
	CN	CIGGT	CP	CN	CIGGT
1		4/3/5/4/4			5/6/5/7/7
3					6/7/6/6/6
5				5/6/5/7/6	
8					5/4/5/6/7
9				6/6/7/7/6	
10	5/6/5/4/6			5/7/5/6/6	
11			5/4/5/4/5		6/6/4/6/6
12	3/3/4/1/3				5/6/5/5/6
13	6/6/7/7/6			7/7/7/7/7	
14		4/6/6/6/6			5/6/5/7/7
17			4/5/5/4/4	6/5/6/6/6	
19			3/3/6/3/3	5/4/5/5/5	
20		4/3/7/4/4			5/4/4/5/6
21		4/4/5/5/5			
22			5/5/7/7/6		
Average Score	6.13	6.75	5.45	5.93	5.8

Rating Scale: 1 = worse, 4 = no change, 7 = better

Table 4 shows the ratings for the comparison of rail surface conditions at six months versus pregrinding. These ratings show that, at the six-month mark, the following results were achieved:

(a) For high rails: The CN pattern produced marginally better rail surfaces (average rating: 4.2); the CIGGT pattern marginally worse (average rating: 3.85); and the CP Research pattern the worst of the three (average rating: 3.3).

(b) For low rails: Both the CIGGT and CN patterns provided visibly better rail surfaces. The CN pattern was, however, slightly better (average rating: 5.73 versus 5.33).

TABLE 4

RELATIVE RATING OF RAIL SURFACE CONDITIONS
PREGRINDING VERSUS SIX MONTHS AFTER GRINDING

Curve No.	High Rail			Low Rail	
	CN	CIGGT	CP	CN	CIGGT
1		3/4/4/2/2			5/6/4/5/5
3					6/7/6/7/7
5				5/6/6/7/7	
8					3/2/4/1/5*
9				6/7/6/7/7	
10	5/3/5/5/6			5/4/4/6/7	
11			5/4/6/6/5		4/3/4/6/5
12	3/1/3/1/2				6/5/5/6/6
13	5/5/6/7/6			7/5/6/7/7	
14		6/5/6/6/6			5/4/3/7/6
17			4/3/5/2/4	5/5/4/5/6	
19			3/1/4/2/2	5/4/4/6/6	
20		3/4/3/2/3			5/6/5/5/6
21		3/3/4/3/3			
22			2/2/2/2/2		
Average Score	4.2	3.85	3.3	5.73	5.33

Rating Scale: 1 = worse, 4 = no change, 7 = better
* rating excluded due to large inconsistency

The above results are summarized in Table 5 which shows that, overall, the CN and CIGGT patterns were successful in improving surface conditions on low rails. For high rails, both could be considered as being successful in preventing further rail surface deterioration. It should be noted that on CP rail surface conditions are known to progressively worsen even though grinding has been carried out twice a year for a long time. In all, the CP Research-recommended pattern performed consistently less well than either the CN or CIGGT patterns.

TABLE 5

RELATIVE RATING OF RAIL SURFACE CONDITIONS
(pregrinding rail surface condition is the reference)

	At Three Months* After Test Grinding	At Six Months* After Test Grinding
High Rails:		
CN pattern	6.13	4.2
CIGGT pattern	6.75	3.85
CP Research Pattern	5.45	3.3
Low Rails:		
CN Pattern	5.93	5.73
CIGGT Pattern	5.80	5.33

* Rating Scale: 1 (worse), 4 (no change), 7 (better)
Tonnage: 4.6 MGT per month

3.3 Wear

Details of the rail profile measurement results are described in two progress reports produced by CP Research. These are included in full as Appendices C and D.

In terms of rail wear (i.e. loss of sectional area), the findings from these reports can be summarized as follows:

(a) No measurable rail wear was observed from rail profile measurements at ten and sixteen weeks

after test grinding. The accuracy of the CP rail profile meter is about ±0.004" for linear wear, indicating that the amount of wear would be within that range.

(b) All grinding patterns produced the same results, indicating that while their differences produced significant effects on rail corrugation and shelling, they have no significant effect on the rail wear rate (again within the accuracy of the CP rail profilometer.

In terms of profile changes, it was found that:

(a) the gauge corner contour produced by all grinding patterns returned to the worn contour after ten weeks

(b) the field side taper on the low rail remained visible longer with the CN grinding pattern than with the CIGGT grinding pattern. This observation applies at sixteen weeks after grinding when the last rail profile measurement was made.

4. DISCUSSION

4.1 On Corrugation Results

The corrugation regrowth results summarized in Figure 10 indicated significant cost savings prospects with use of the CIGGT grinding pattern. The CIGGT corrugation regrowth curve in Figure 10 indicates that the growth rate of corrugation is very small up to four months. If grinding is carried out at this time, the following benefits could be achieved:

(a) Only one grinding pass would be required because corrugation levels are small and the rail surface is still in good condition. This could lead to reduction in grinding costs. Grinding with one pass is more efficient in terms of grinding time compared to two-pass grinding, as no stop/start is required. The prospect is even better if the grinding train can be set up to go from one end of the track to the other without backtracking. However, this cost saving potential needs further evaluation with the specific operational constraints taken into account.

(b) The track will last longer if the average corrugation throughout the year is kept at a lower level. Based on data in Figure 10, this level could be between 0.004" and 0.008", compared to 0.004" to 0.020" produced by previous CP grinding. Related benefits also apply to rolling stock, especially wheels and fuel consumption.

The CIGGT and CN grinding patterns both produced a corrugation level significantly lower than that at pre-grinding. Relatively, the CIGGT pattern produced better results. It should be noted that for a truly scientific comparison, both the CIGGT and CN patterns must be applied to the same base, i.e. the same rail conditions, same pre-grinding corrugation levels, same curvatures, same grades, etc. These conditions could not be fully met in this test. This shortfall must be considered in any critical comparative evaluation of grinding patterns.

4.2 On Shelling and Spalling Results

The rating results summarized in Table 6 indicate that:

(a) For high rail: The CN pattern, with its greater extent of gauge corner grinding, is better than the CIGGT pattern if a six-month grinding cycle is used. If the grinding cycle is shortened to every four months, the CIGGT pattern would be better. The additional benefits of the CN gauge corner grinding can be obtained by shifting two grinding wheels to the gauge corner (in an angle range of 7 to 25 degrees).

The CP Research pattern does not appear to be beneficial, either in terms of surface fatigue or gauge face wear.

For both the CN and CIGGT patterns, the average rating at six months is around 4, which indicates no change in rail surface conditions. Considering that rail surface conditions normally deteriorate with time under the existing twice-a-year grinding program, a rating of 4 is a positive achievement. It implies that if these patterns were applied from the time of installation, when the rails are still new, good rail surface quality would be retained. This would reduce shelling as a reason for rail removal and hence increase rail life. Further improvements in rail life would also be

achieved because good surface conditions would permit a higher allowable rail wear limit.[5]

(b) For low rail: The CN pattern is slightly better than the CIGGT pattern. Both, however, performed very well in the test. It is not clear why the CN pattern produced a better surface while it was inferior in reducing rail corrugation. One explanation is that the field side taper produced by the CN pattern lasted longer, and hence was more effective in controlling false flange contact. This is, however, not entirely logical, since false flange contact is known to directly affect corrugation, and, as such, implies better corrugation control by the CN pattern.

Another explanation is that the CN test curves have higher initial corrugation levels. This trend is, however, not consistent in the test (re: Figures 6 and 7).

One factor which must be considered in comparing the CN and CIGGT patterns for low rails is that the data on corrugation are much more specific and in-depth than those for surface fatigue shelling (40 quantitative measurement sites versus the subjective evaluation of one photograph).

The appropriate action would be to incorporate more grinding of the low-rail field-corner into the CIGGT pattern. Care must be taken to ensure that the corrugation control quality of the CIGGT pattern is not adversely affected. This work must be carried out through further field trials. However, considering the narrow scope for further improvement, it does not appear to be immediately necessary.

4.3 On Wear Results

The rail profile measurements, which show very little wear from all grinding patterns,[6] indicate that the rate of rail wear is not highly sensitive to the extent of gauge corner grinding. However, a longer

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5 This has been practiced safely at Hamersley Iron Railway (33-ton axle load, 60 MGT per year) for several years. Ref: W.R. Fahey. "The Impact of Track Technology on Heavy-Haul Operations." Pre-Proc. of the "Track Technology for the Next Decade" Conference, 11-13 July 1984, University of Nottingham, U.K.

6 Within the accuracy of the CP rail profilometer (see Section 3.3).

monitoring program (long enough for wear to be measurable with the CP Research instrument) is needed to verify this observation.

In the initial field test, lateral wheel forces were used as an indirect measurement of the effect of gauge corner grinding on rail wear. The results indicated a sharp increase in lateral wheel forces when CN-like gauge corner grinding was produced in the 4° test curve. Based on the results of this test, one may suspect that the increase in lateral wheel forces does not remain sufficiently long to significantly affect rail wear.

5. CONCLUSION

The second of two field tests involving fifteen test curves has been carried out. The results of a rail condition monitoring program indicated that at six months after the test grinding, during which 18 MGT of traffic passed over the rails:

(a) Both the CIGGT and CN grinding patterns for low rails produced corrugation levels significantly lower than those at pre-grinding. Relatively, the CIGGT pattern produced better results.

(b) Both the CIGGT and CN grinding patterns produced rail surface conditions noticeably better than those at pre-grinding. Relatively, the CN pattern produced a better result. The CIGGT pattern for low rails can be further refined with extra grinding of field corners to achieve the CN results for rail surface conditions and reduce the formation of flow lip.

(c) CIGGT and CN grinding patterns for high rails both prevented further deterioration in rail surface conditions (e.g. shelling and spalling). Relatively, the CN pattern produced better results. The CIGGT pattern for high rails can be further refined with two extra grinding wheels on the gauge corner to achieve the CN result for rail surface conditions.

(d) Gauge corner grinding can be from as little as in the CP Research pattern, to as much as in the CN pattern, without significant effect on rail wear.

(e) In track locations where a grinding program with two grinding passes every six months is applied, an

alternative grinding program of one grinding pass every four months would appear to be more efficient and provide more benefit to track maintenance.

6. RECOMMENDATIONS

Based on the results of the test, the following recommendations are offered:

(a) Employ the CIGGT grinding pattern (#0 for high rails and #1 for low rails) in all curved track grinding.

(b) Investigate the potential benefit of changing the present rail grinding schedule to every four months, with the grinding train proceeding from one end of the track to the other without backtracking.

7. ACKNOWLEDGEMENTS

This project was a cooperative effort between CP Rail, CP Research, Speno Rail Services, the Transportation Development Centre of Transport Canada, and the Canadian Institute of Guided Ground Transport. The work was coordinated and directed by a steering committee whose members are Messrs M. Roney (CP Rail), Chairman; W. Liddell (CP Rail); R. Gonsalves (CP Research); A. Zarembski (Speno); W. Rowan (Transport Canada); and S. Lamson (CIGGT).

The CN grinding settings used in the test are part of a comprehensive grinding setting design produced by CN Rail for CN track conditions.

The field recording of rail corrugation and shelling was carried out by Mr. D. Boshart (CP Rail, Pacific Region, Canyon Division). The measurement of rail profiles was carried out by CP Research. Miss C.A. Dixon and Mr. J.D. Young (CIGGT) assisted in the data reduction. Mrs. S.N. Arnold (CIGGT) edited and typed the report. Final editing was carried out by Messrs C.J. Boon and J.S. Bryce (CIGGT).

The author gratefully acknowledges these contributions.

APPENDIX A

DETAILS OF CORRUGATION REGROWTH IN THE TEST CURVES

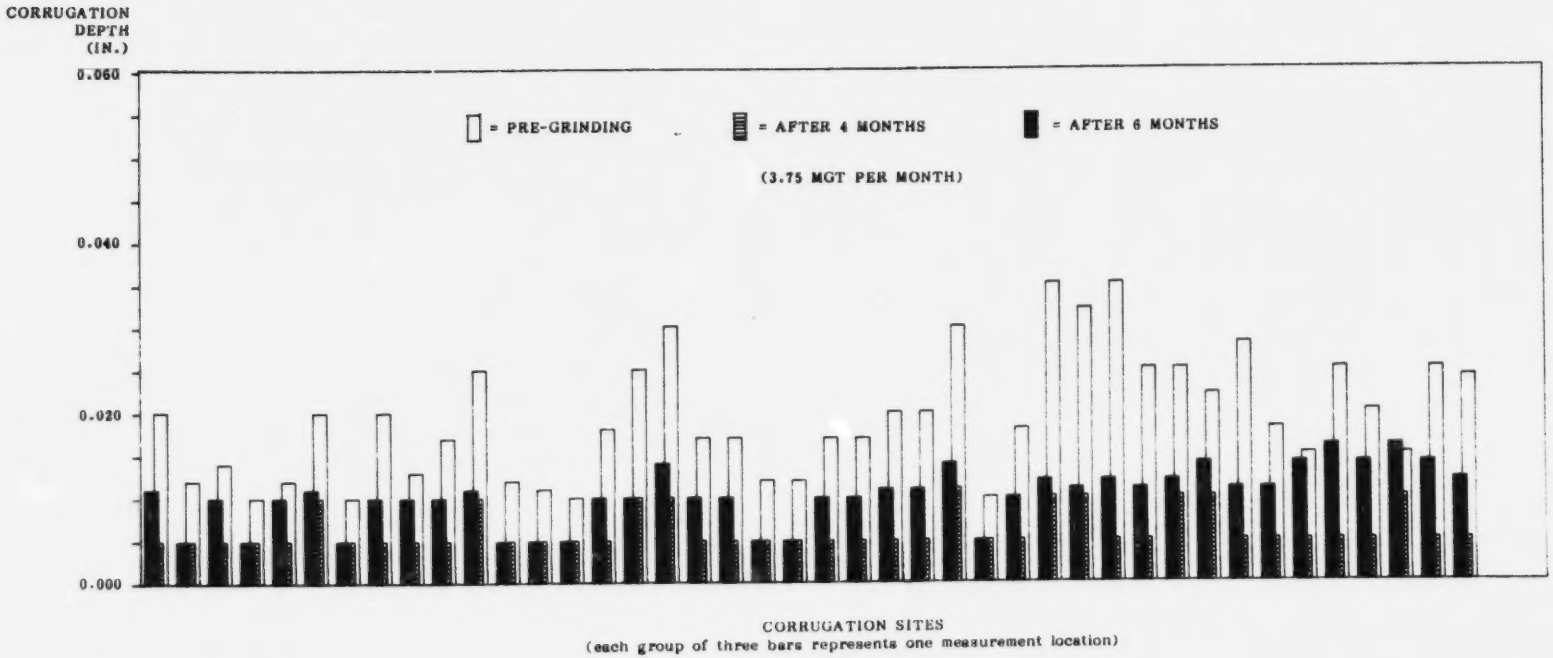


Figure A.1 Details of corrugation regrowth in test curve #1
(4 degrees, chrome rail, MP 26.0, CIGGT grinding pattern)

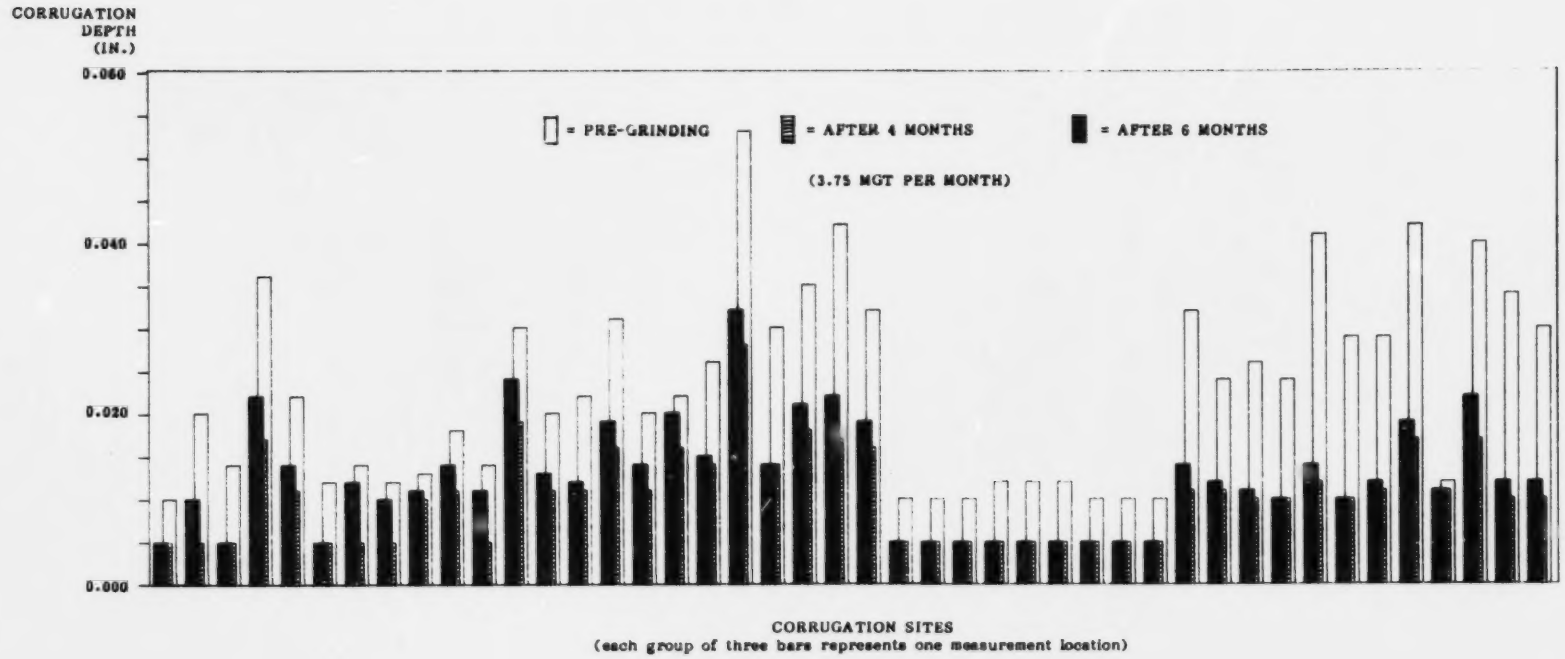


Figure A.2 Details of corrugation regrowth in test curve #9
(4 degrees, chrome rail, MP 8.9, CN grinding pattern)

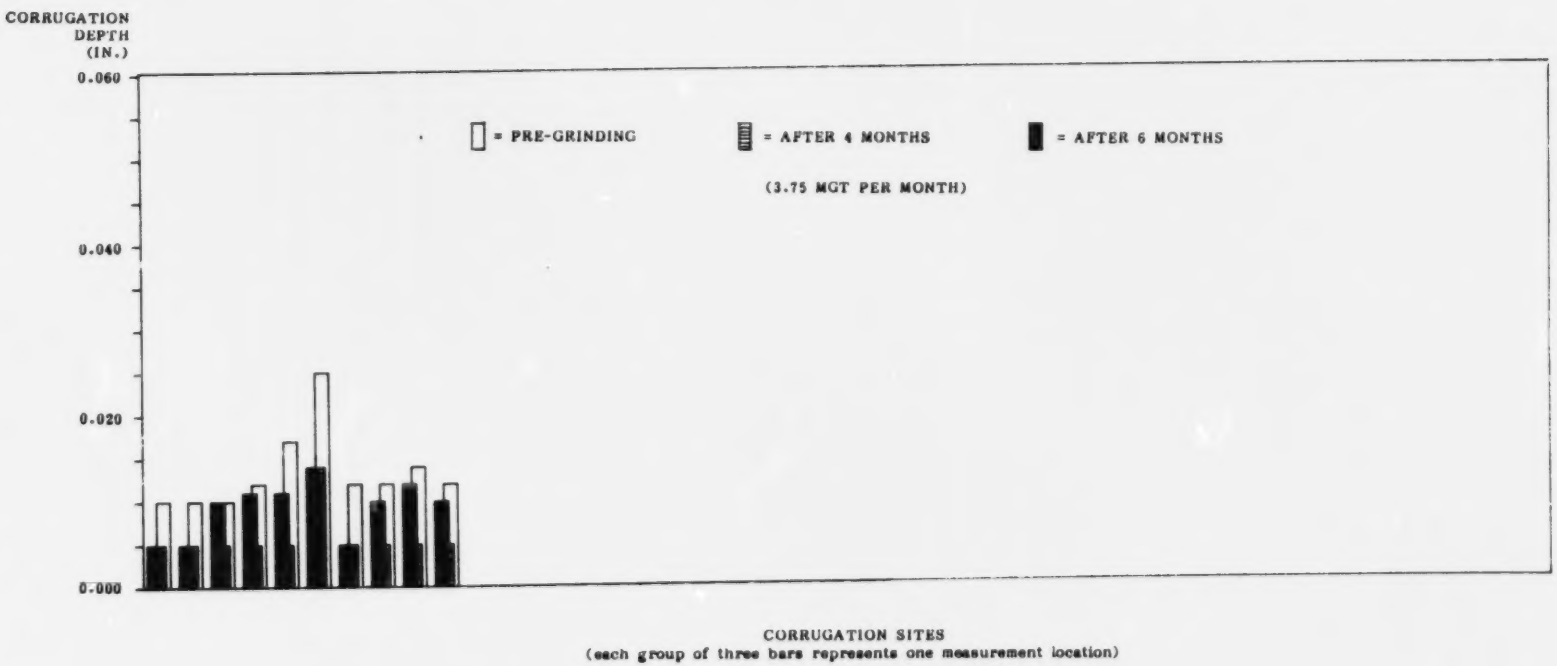


Figure A.3 Details of corrugation regrowth in test curve #3
(7.5 degrees, chrome rail, MP 25.5, CIGGT grinding pattern)

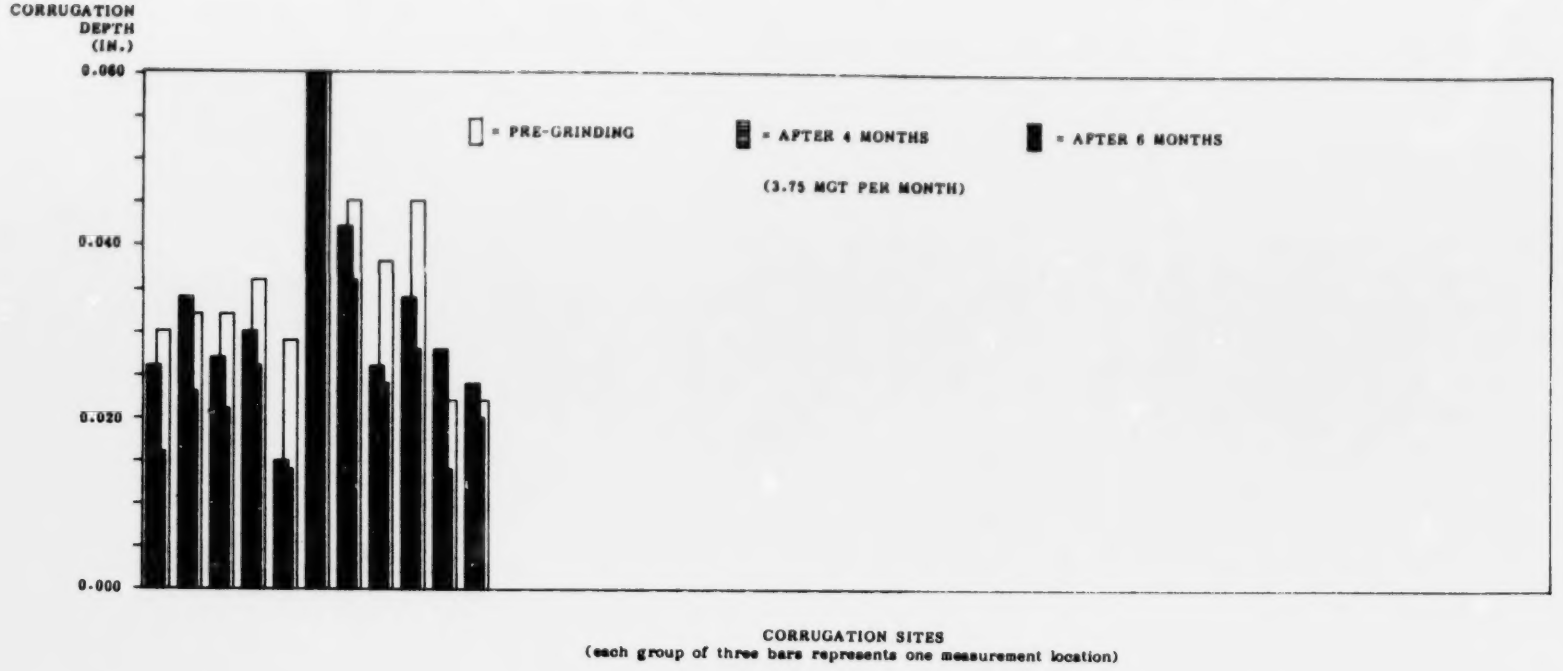


Figure A.4 Details of corrugation regrowth in test curve #5
(8 degrees, chrome rail, MP 24.3, CN grinding pattern)

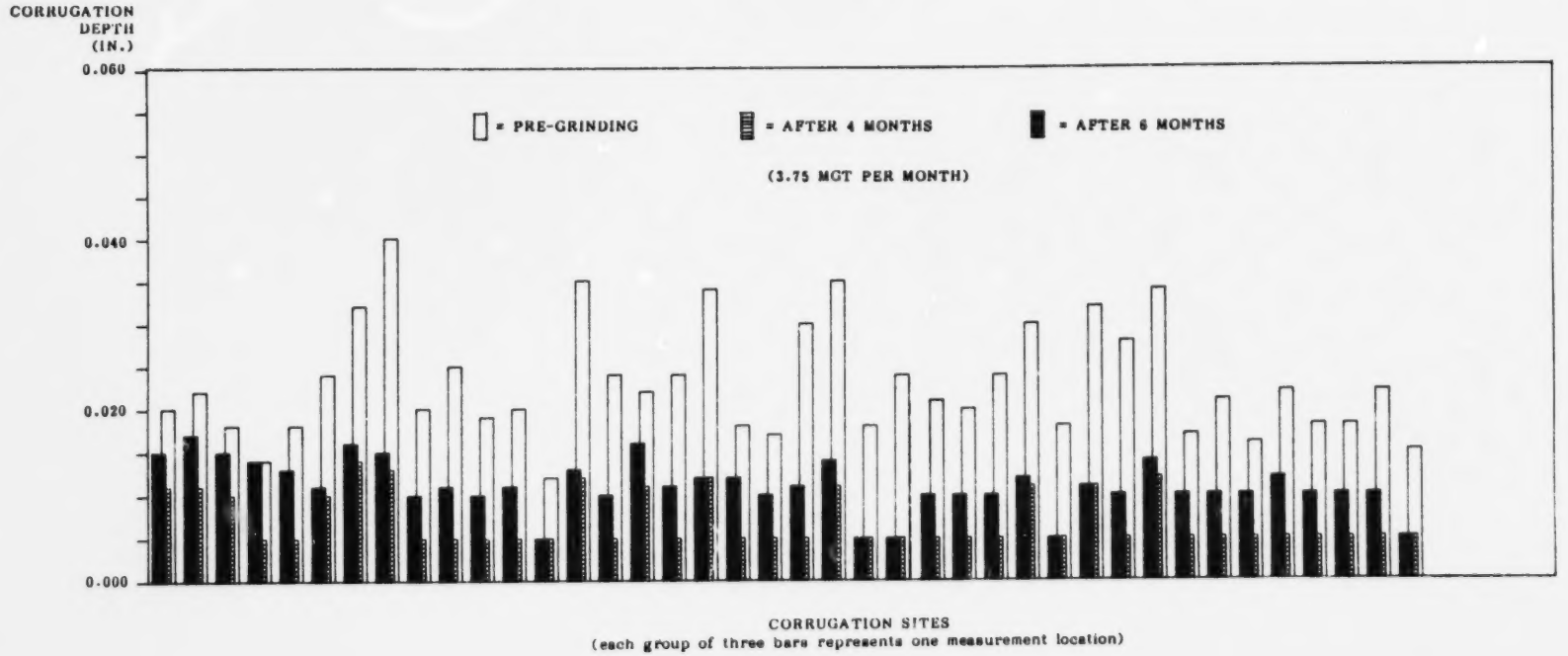


Figure A.5 Details of corrugation regrowth in test curve #8
(8 degrees, chrome rail, MP 8.5, CIGGT grinding pattern)

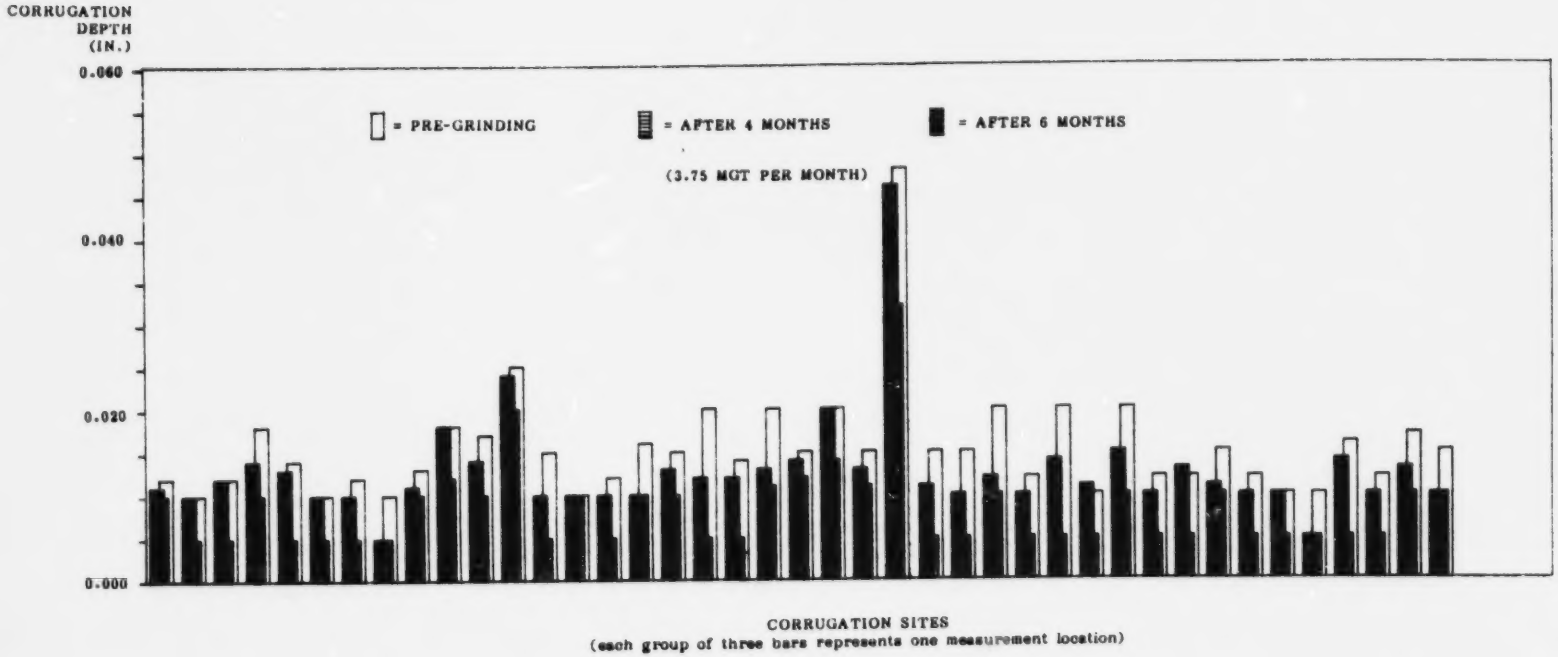


Figure A.6 Details of corrugation regrowth in test curve #20
(8 degrees, chrome rail, MP 17.1, CIGGT grinding pattern)

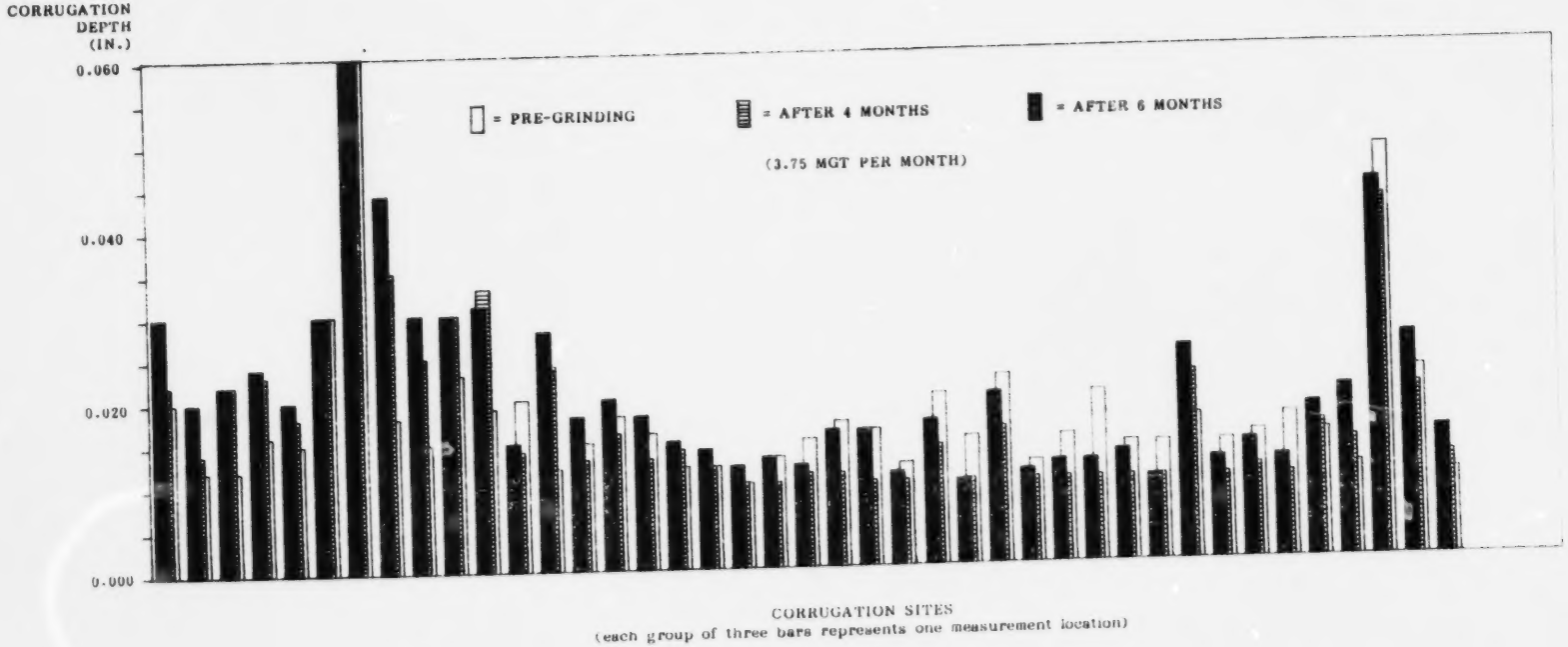


Figure A.7 Details of corrugation regrowth in test curve #19
(8 degrees, chrome rail, MP 17.0, CN grinding pattern)

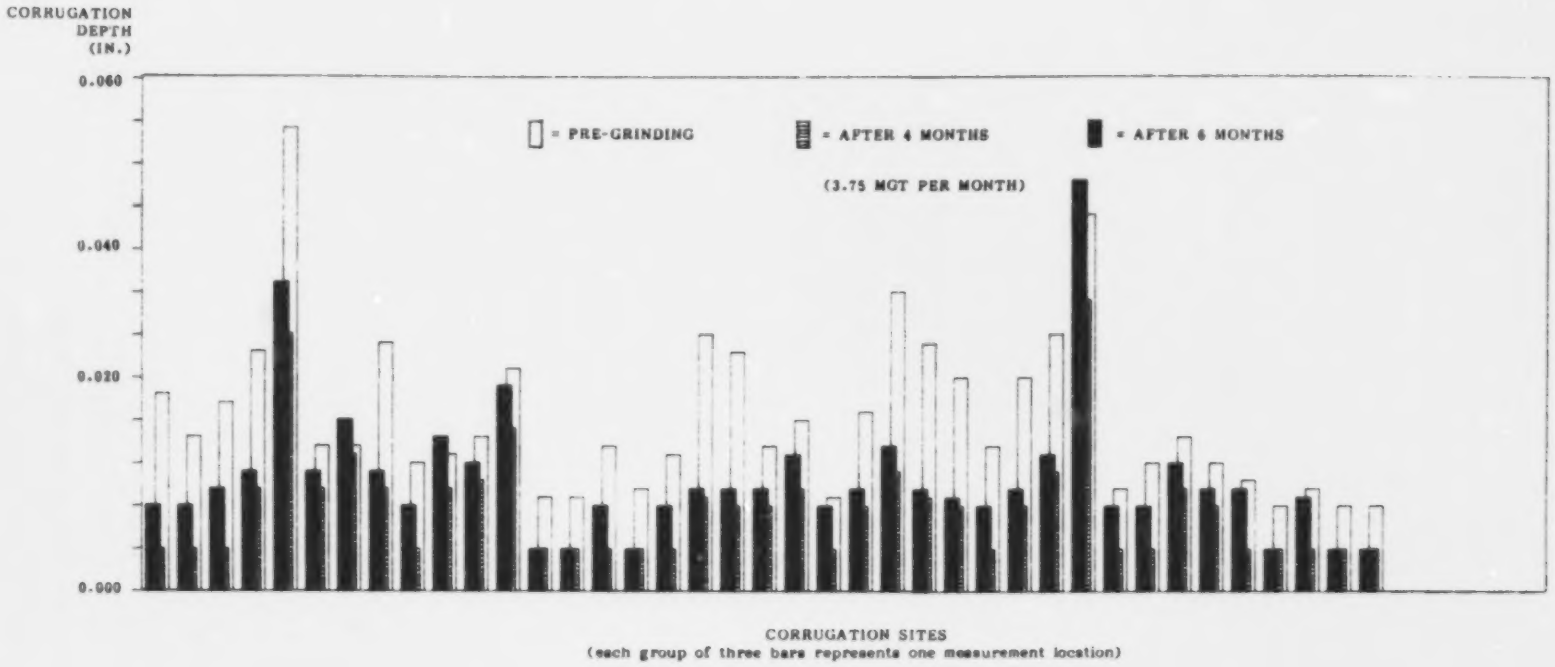


Figure A.8 Details of corrugation regrowth in test curve #14
(8 degrees, chrome rail, MP 10.6, CIGGT grinding pattern)

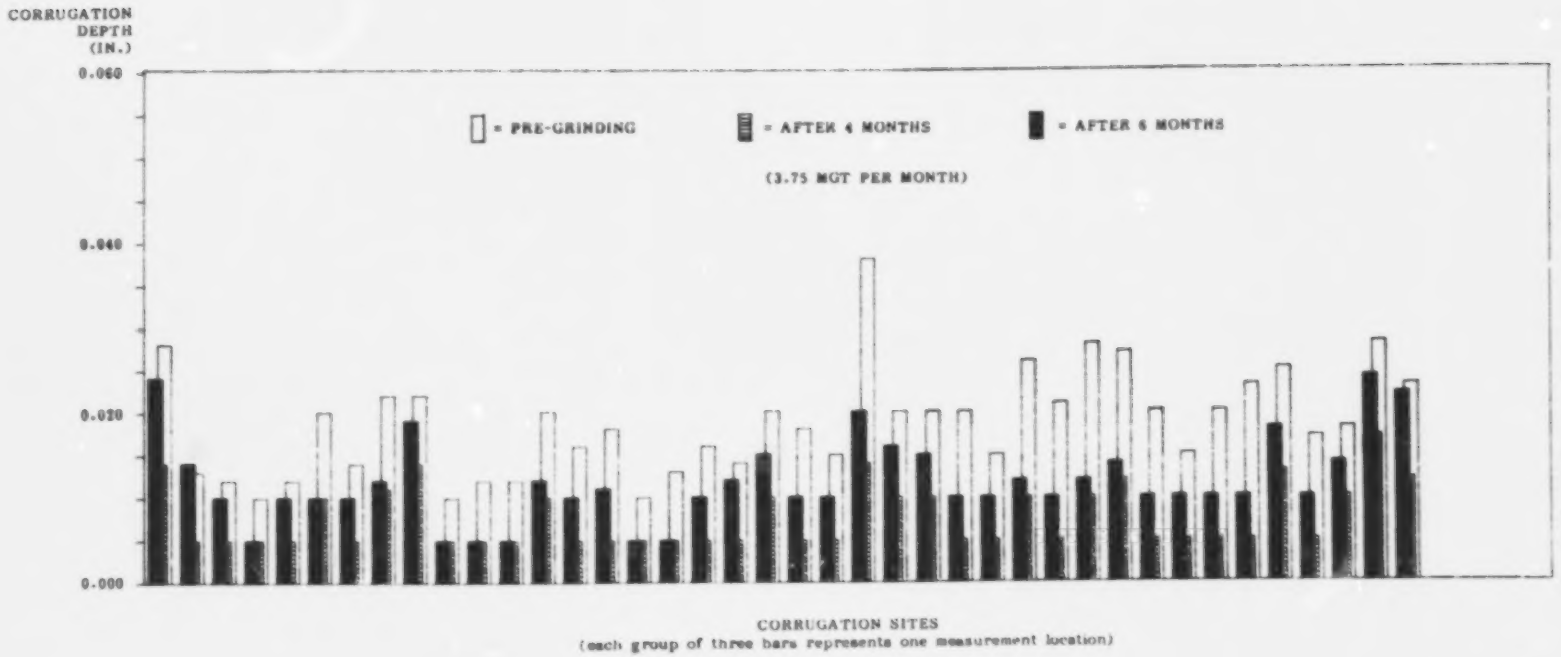


Figure A.9 Details of corrugation regrowth in test curve #13
(8 degrees, chrome rail, MP 10.6, CN grinding pattern)

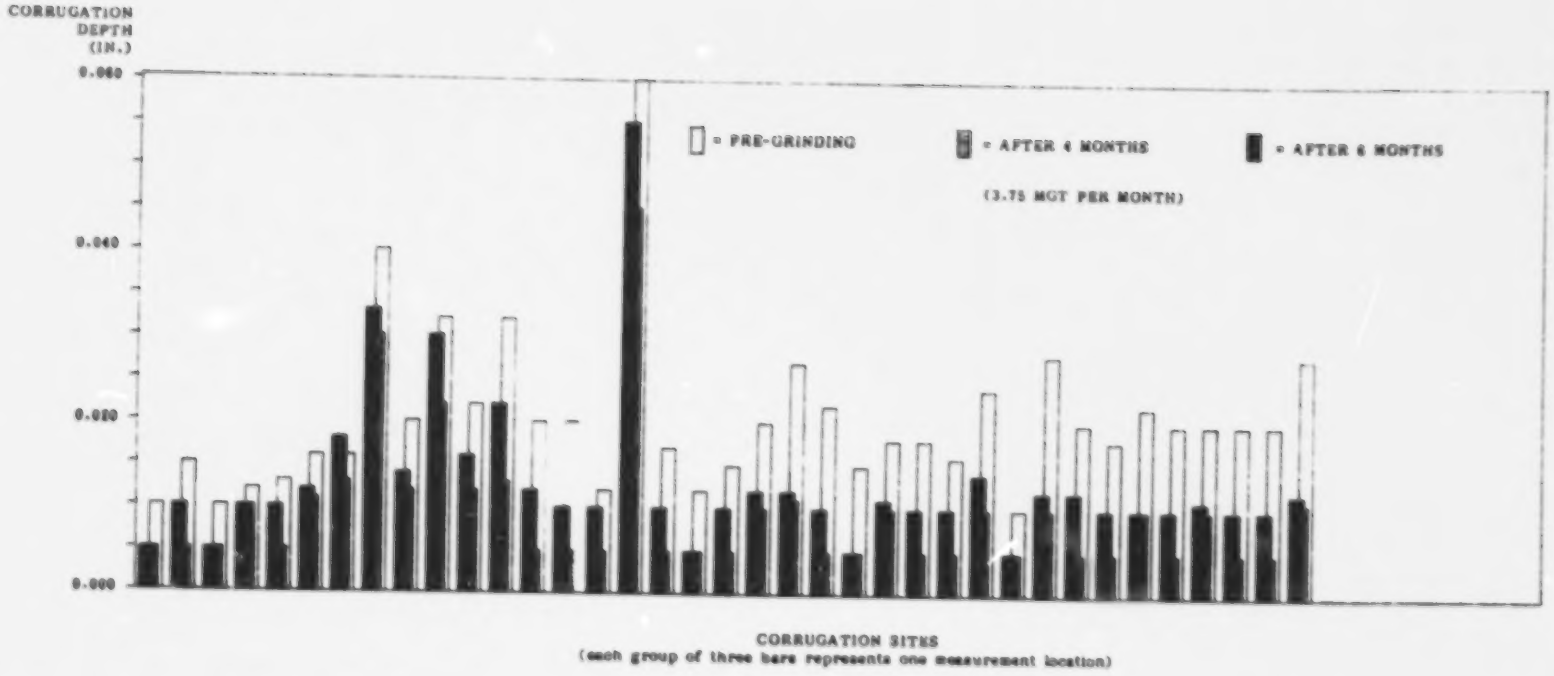


Figure A.10 Details of corrugation regrowth in test curve #12
(4 degrees, chrome rail, MP 10.0, CIGGT grinding pattern)

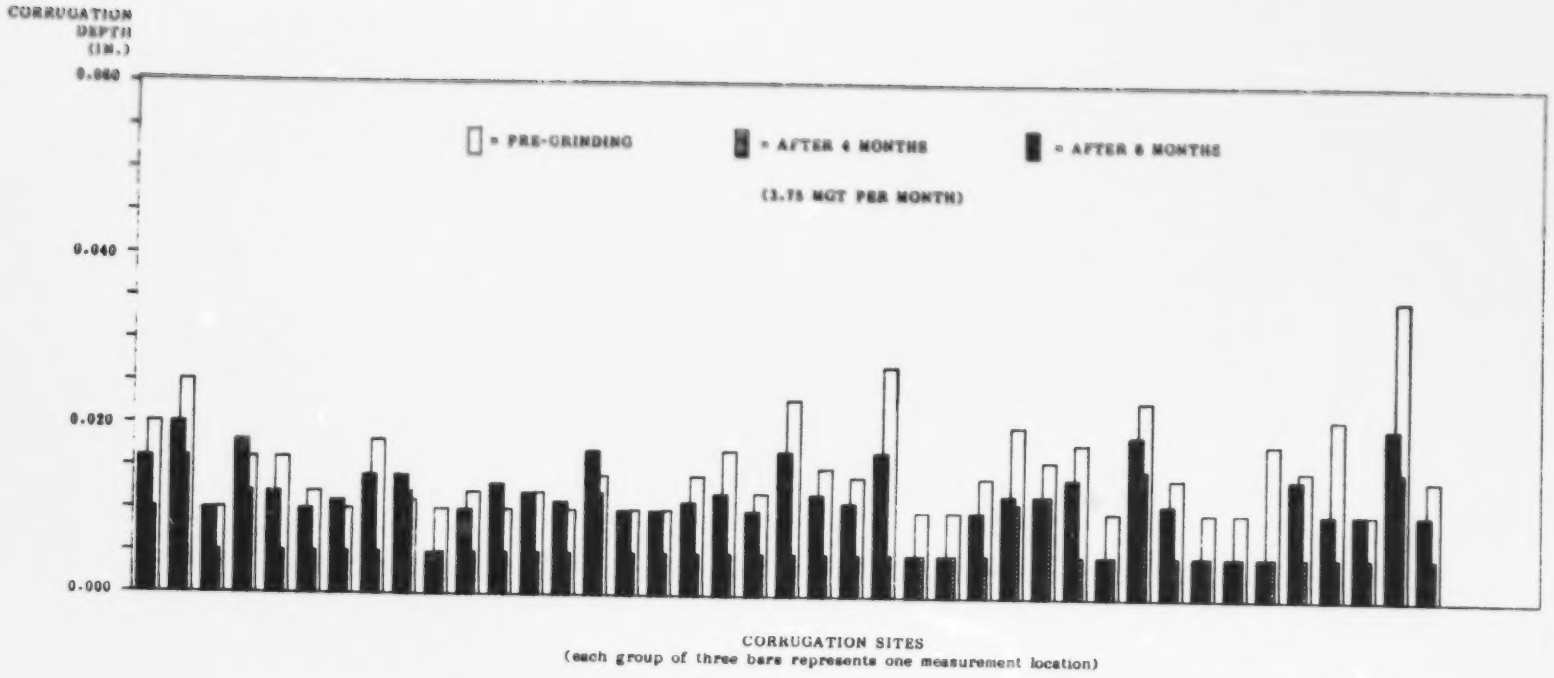


Figure A.11 Details of corrugation regrowth in test curve #17
(4 degrees, chrome rail, MP 13.5, CN grinding pattern)

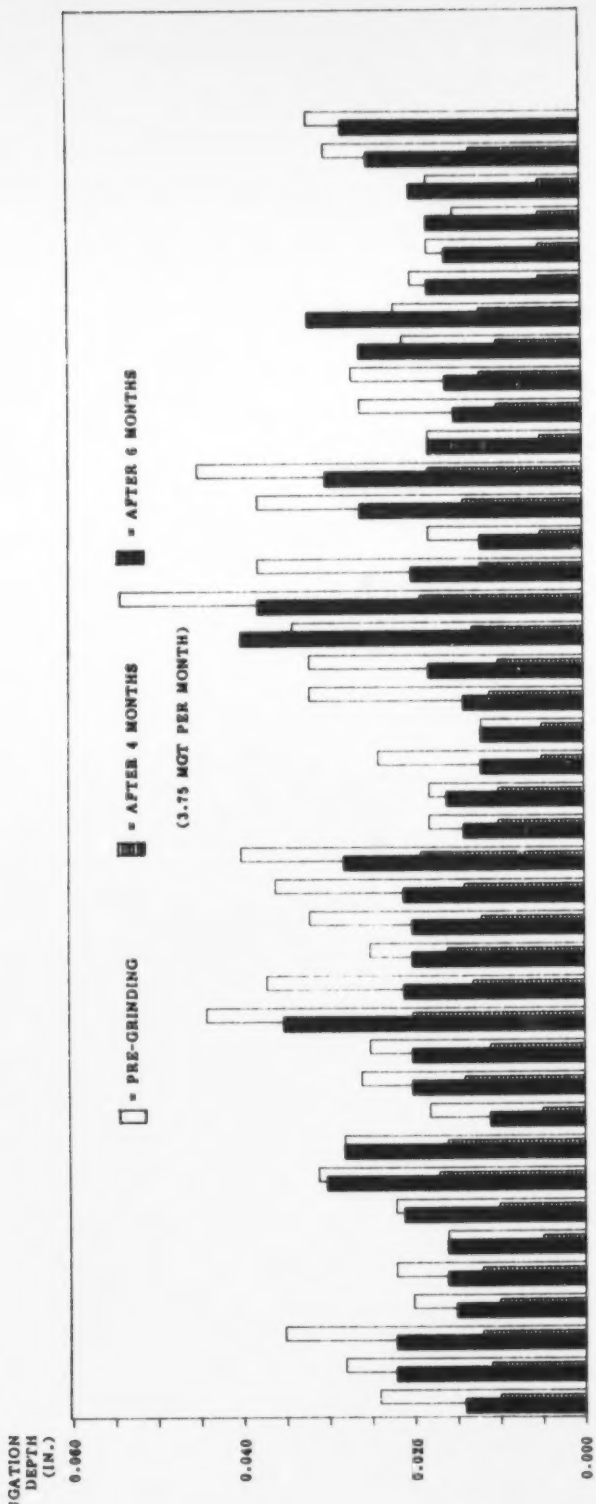


Figure A.12 Details of corrugation regrowth in test curve #11
(8 degrees, chrome rail, MP 9.6, CIGGT grinding pattern)

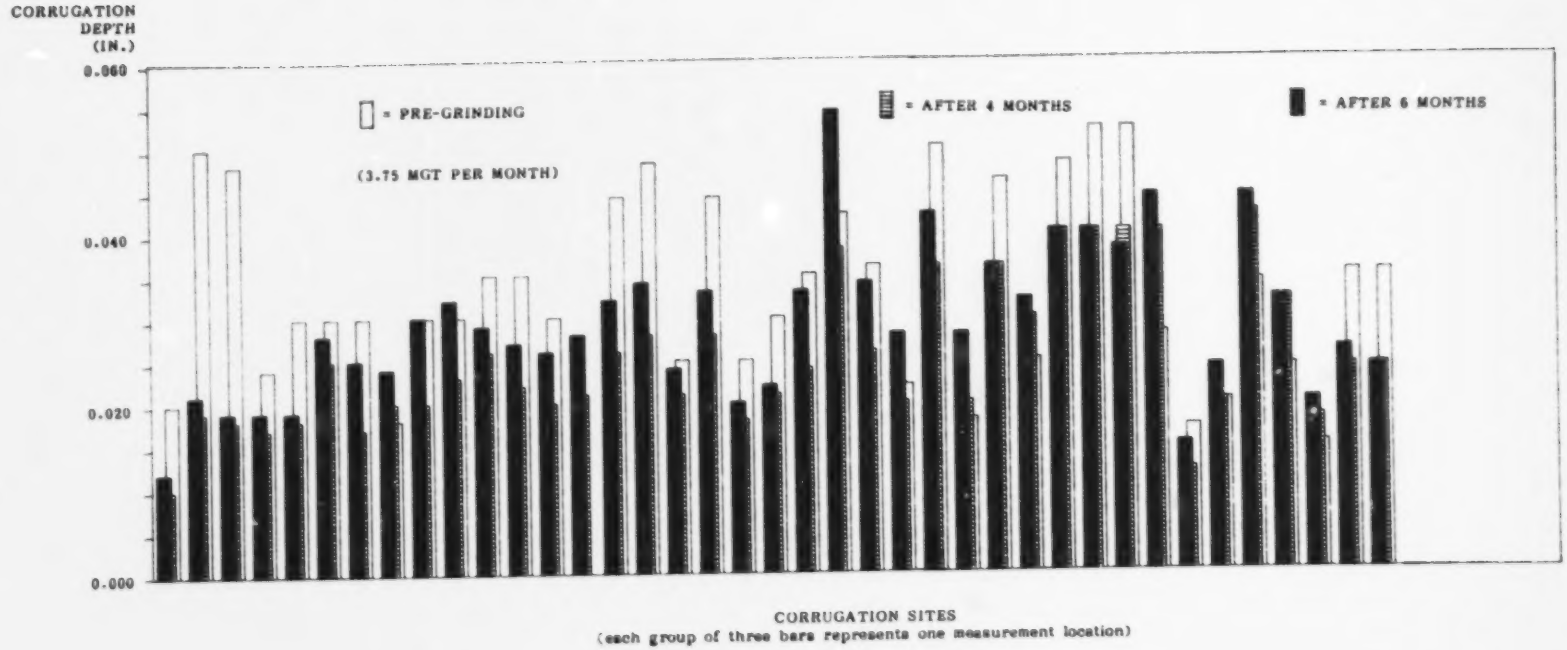
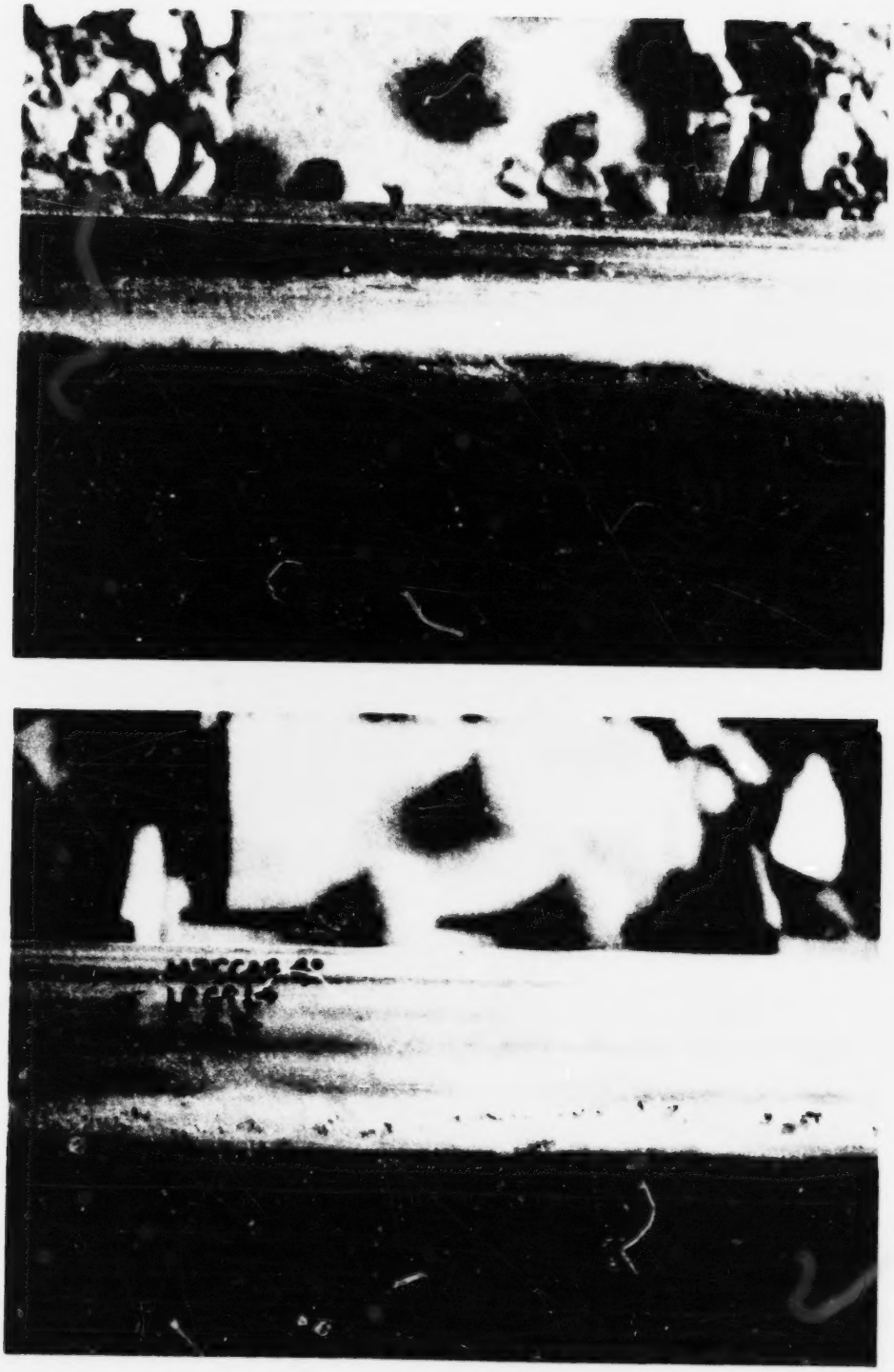


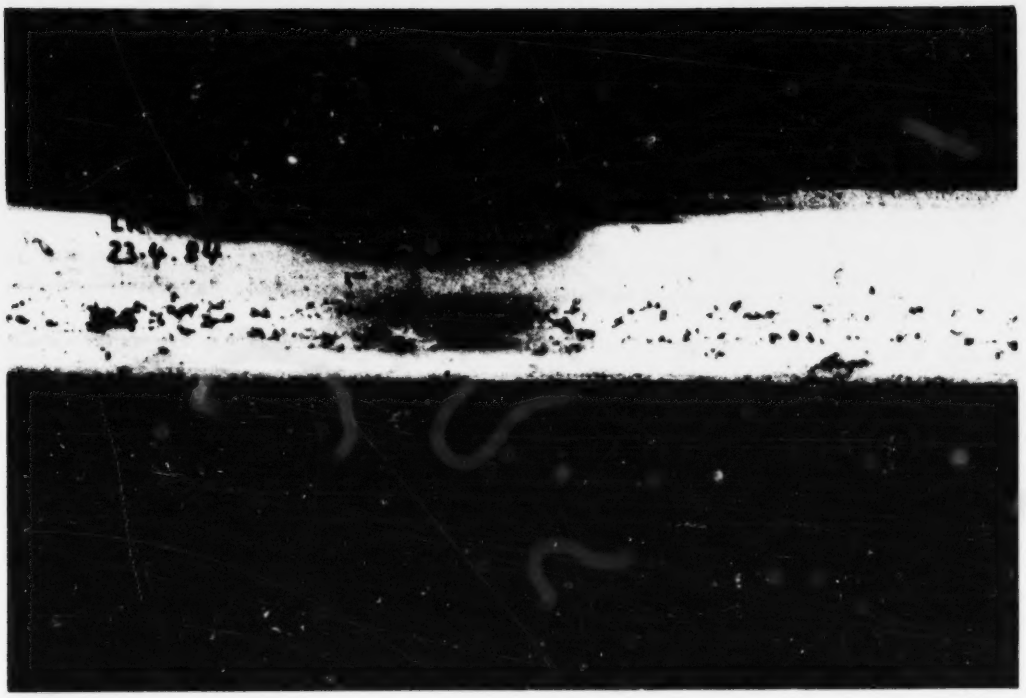
Figure A.13 Details of corrugation regrowth in test curve #10
(8 degrees, chrome rail, MP 9.5, CN grinding pattern)

APPENDIX B

DETAILS OF RAIL SURFACE CONDITIONS IN THE TEST CURVES

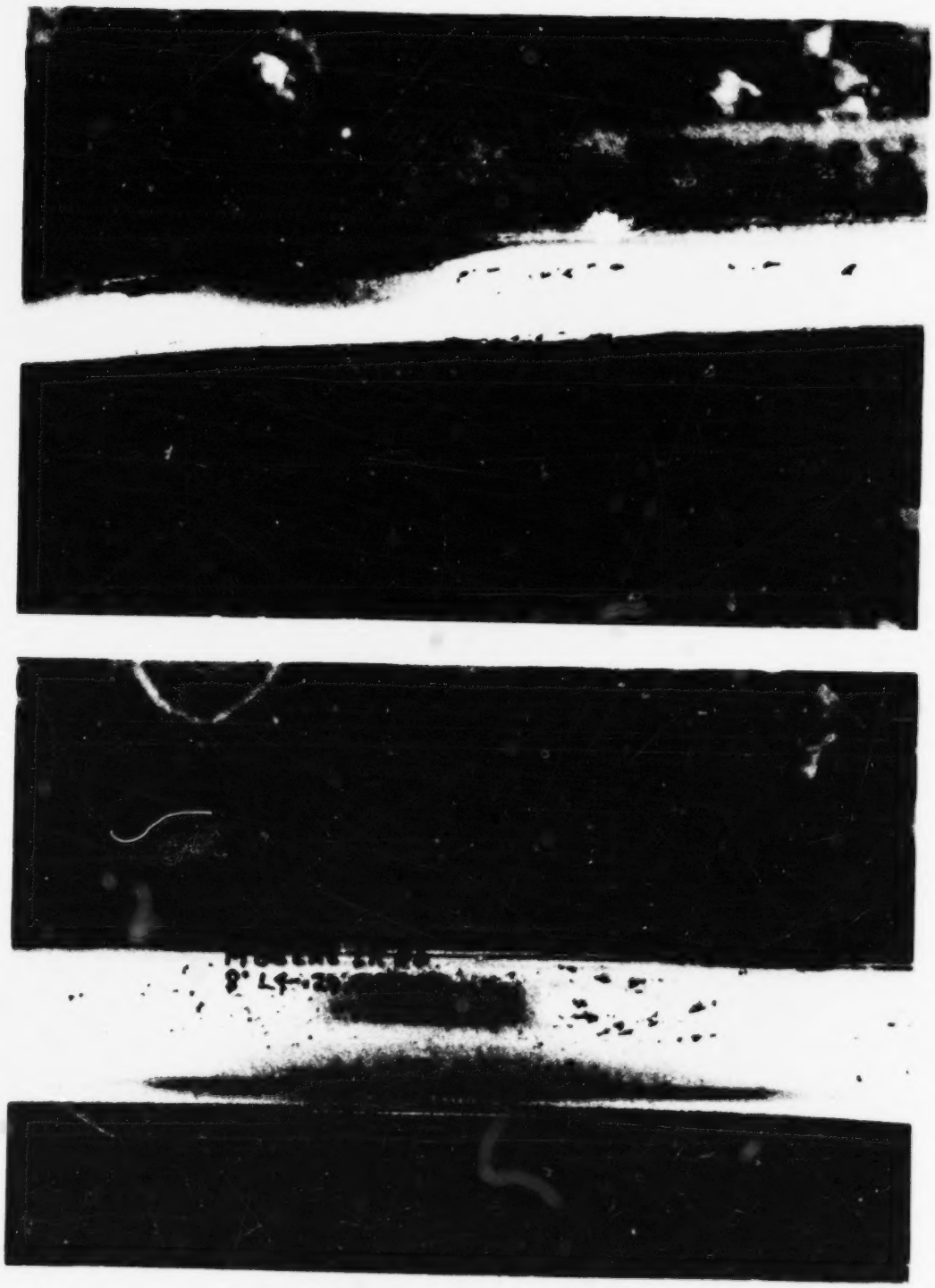


Pregrinding, Curve No. 1, MP 26.0

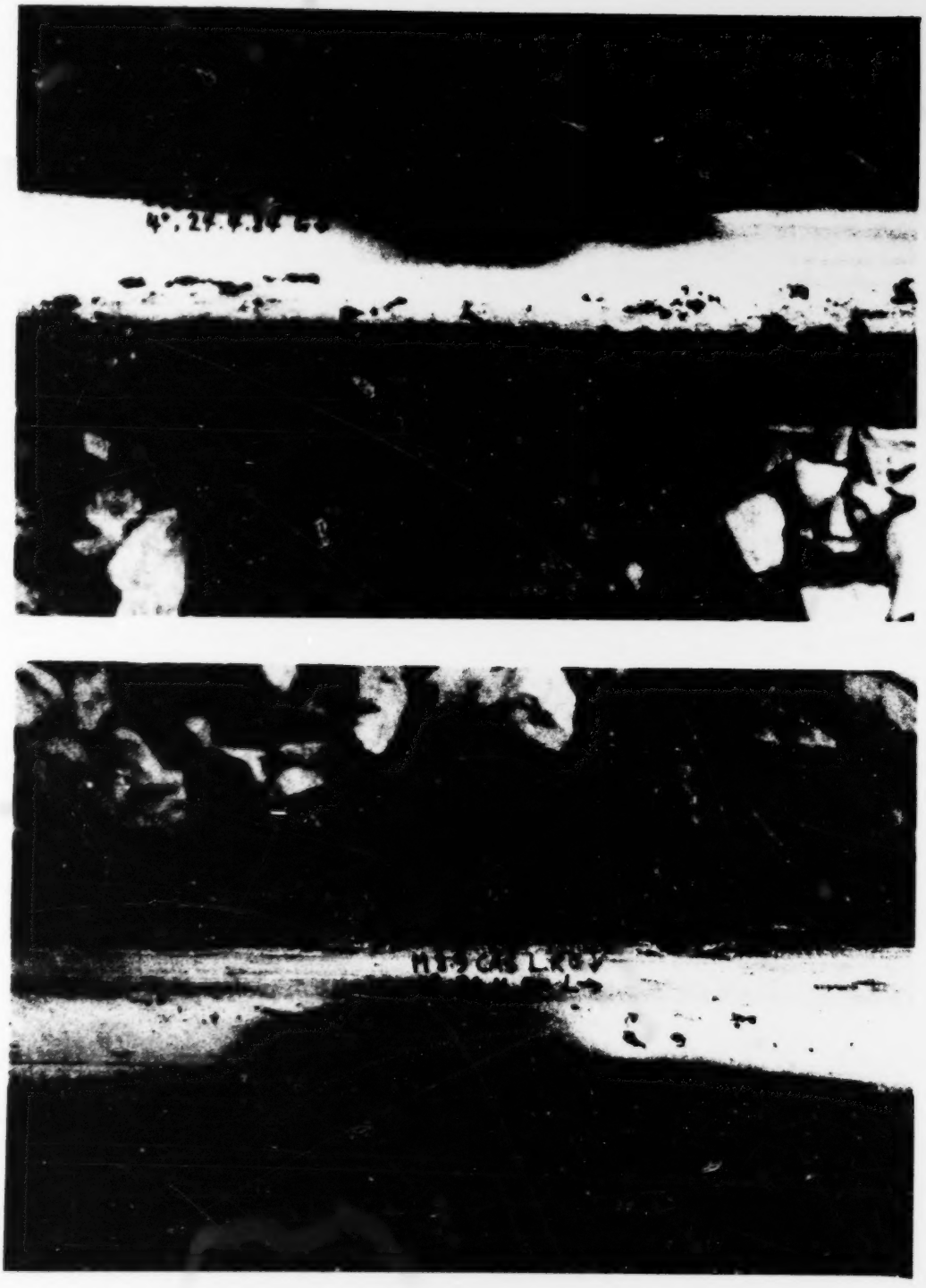


Pregrinding, Curve No. 3, MP 25.5

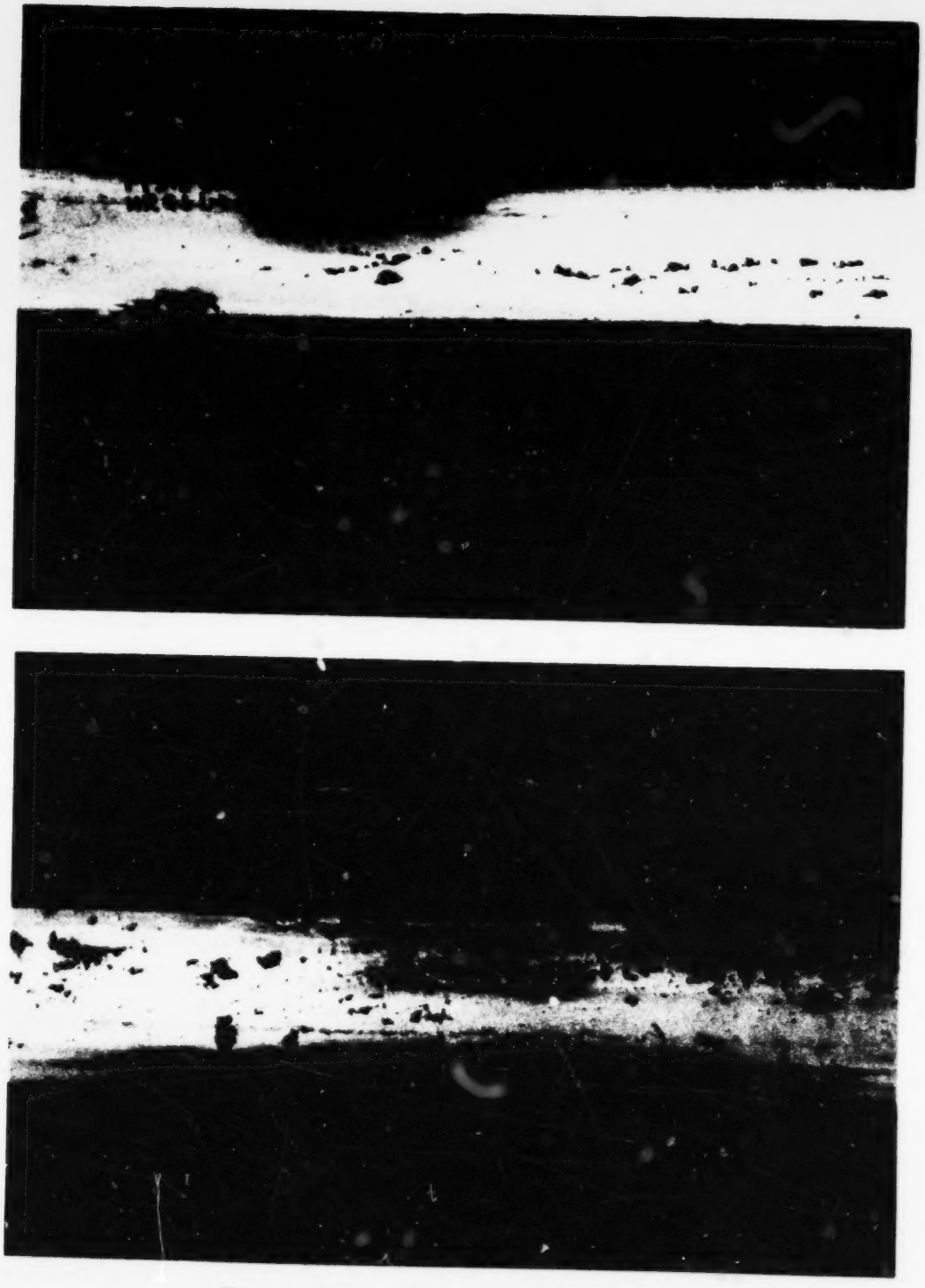
Pregrinding, Curve No. 5, MP 24.3



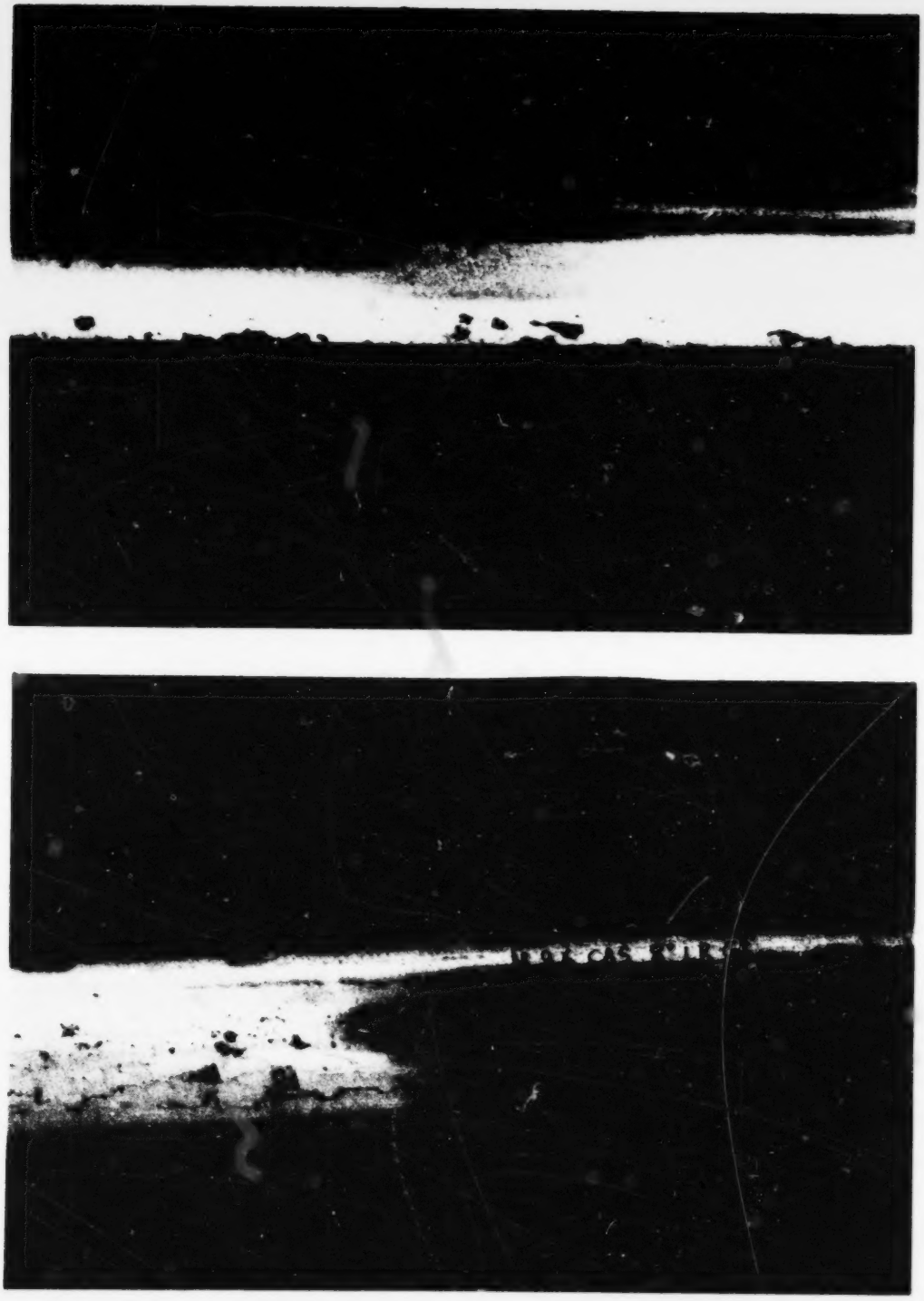
Pregrinding, Curve No. 8, MP 8.5



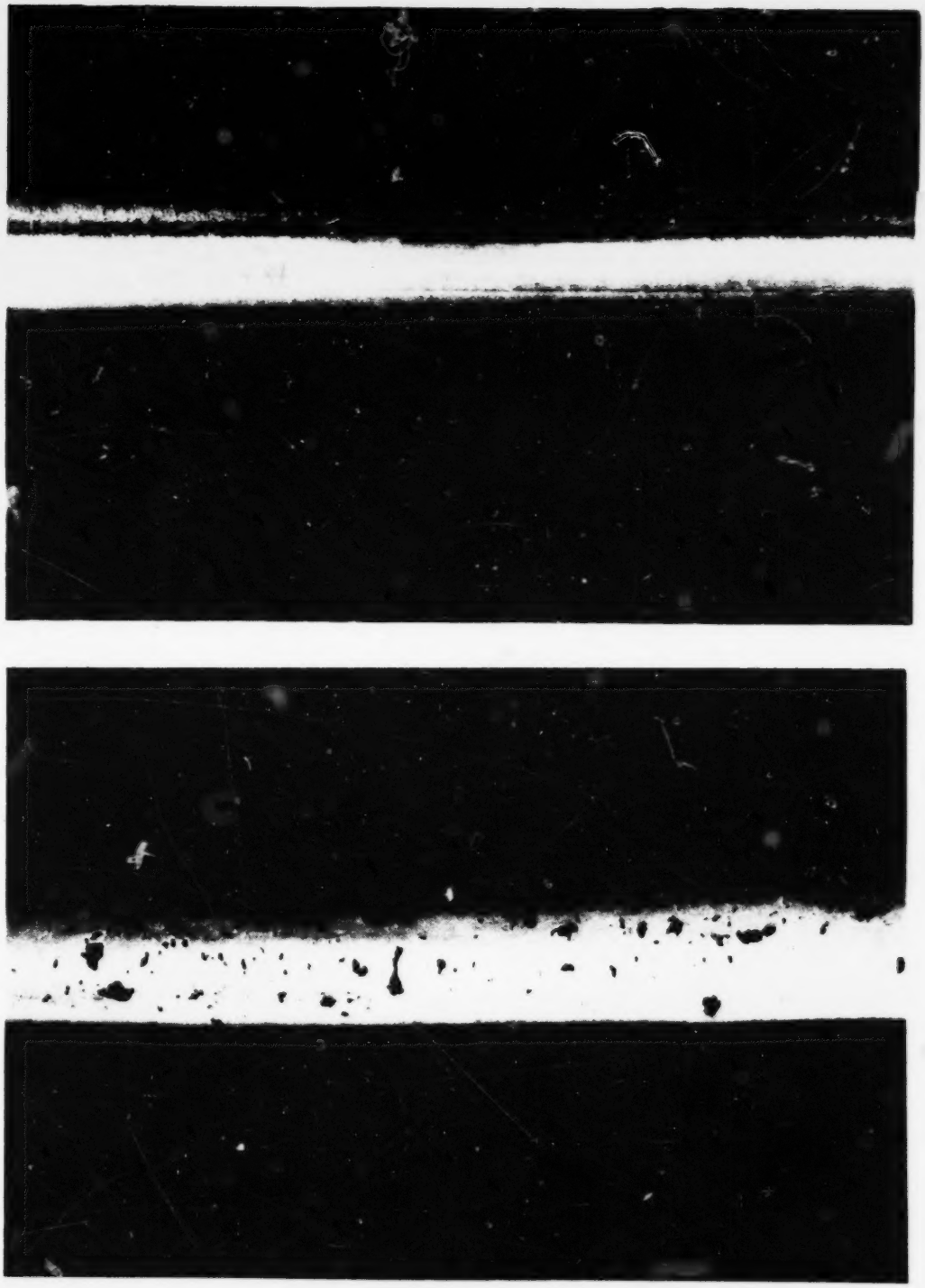
Pregrinding, Curve No. 9, MP 8.9



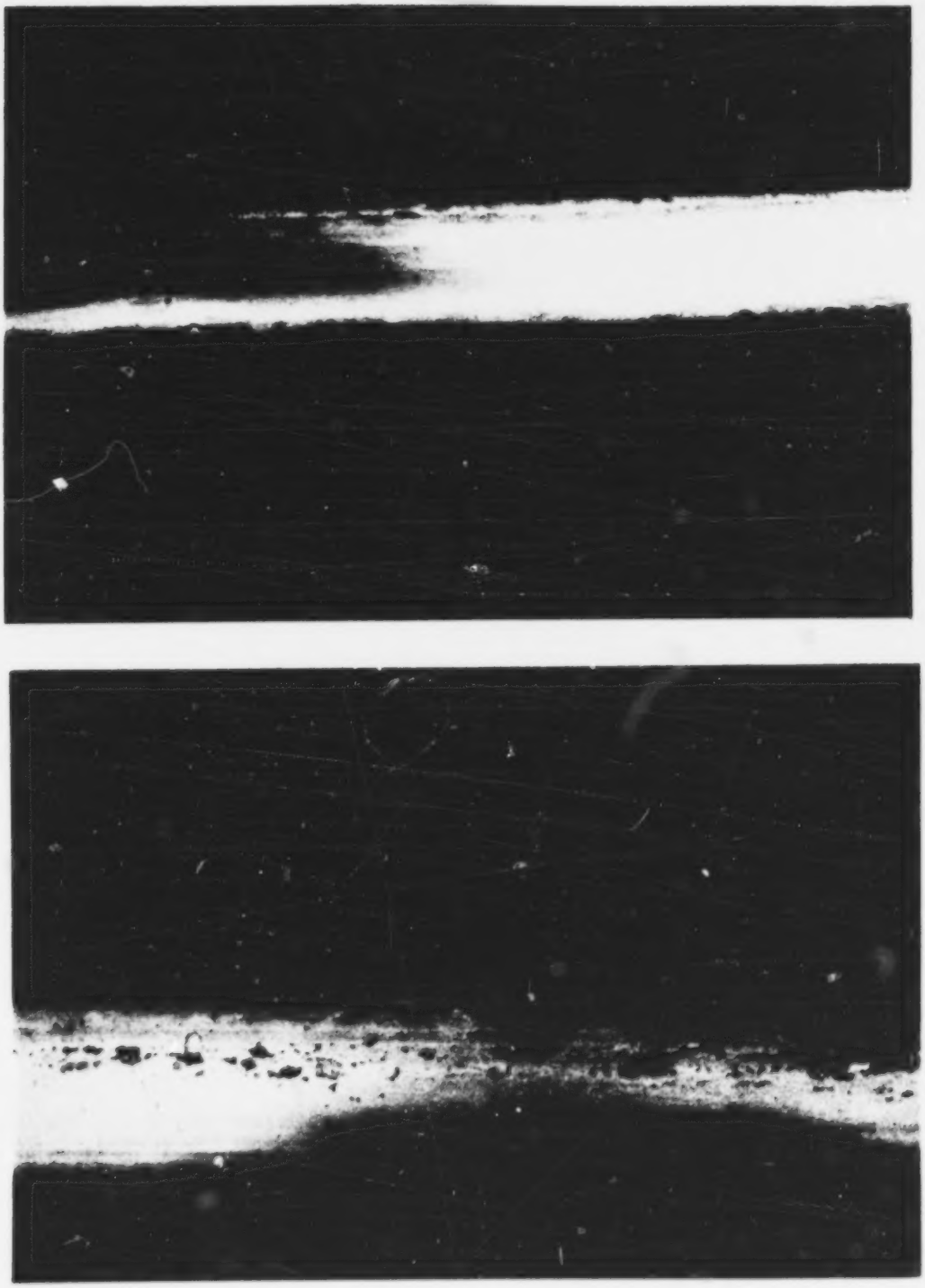
Pregrinding, Curve No. 10, MP 9.5



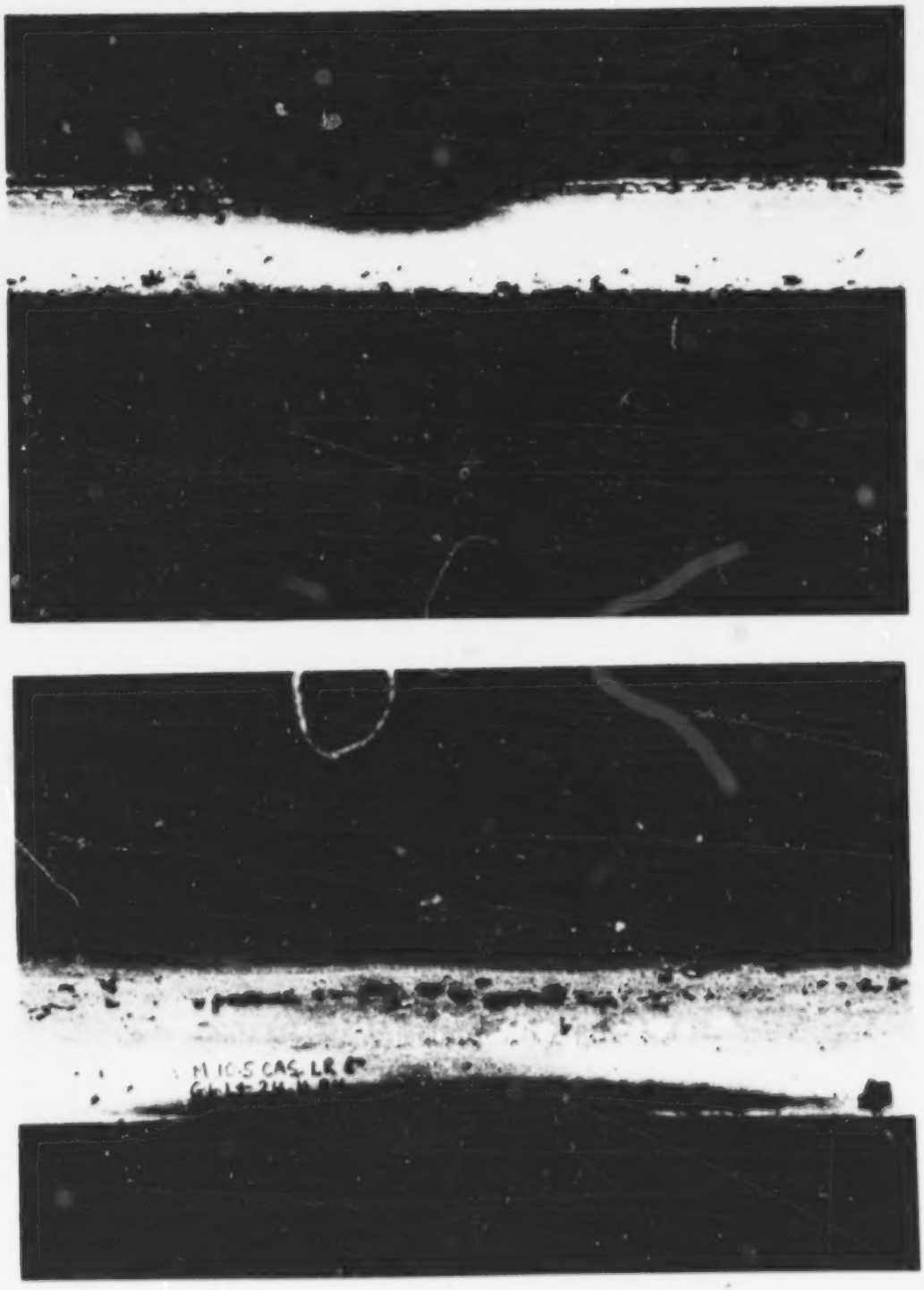
Pregrinding, Curve No. 11, MP 9.6



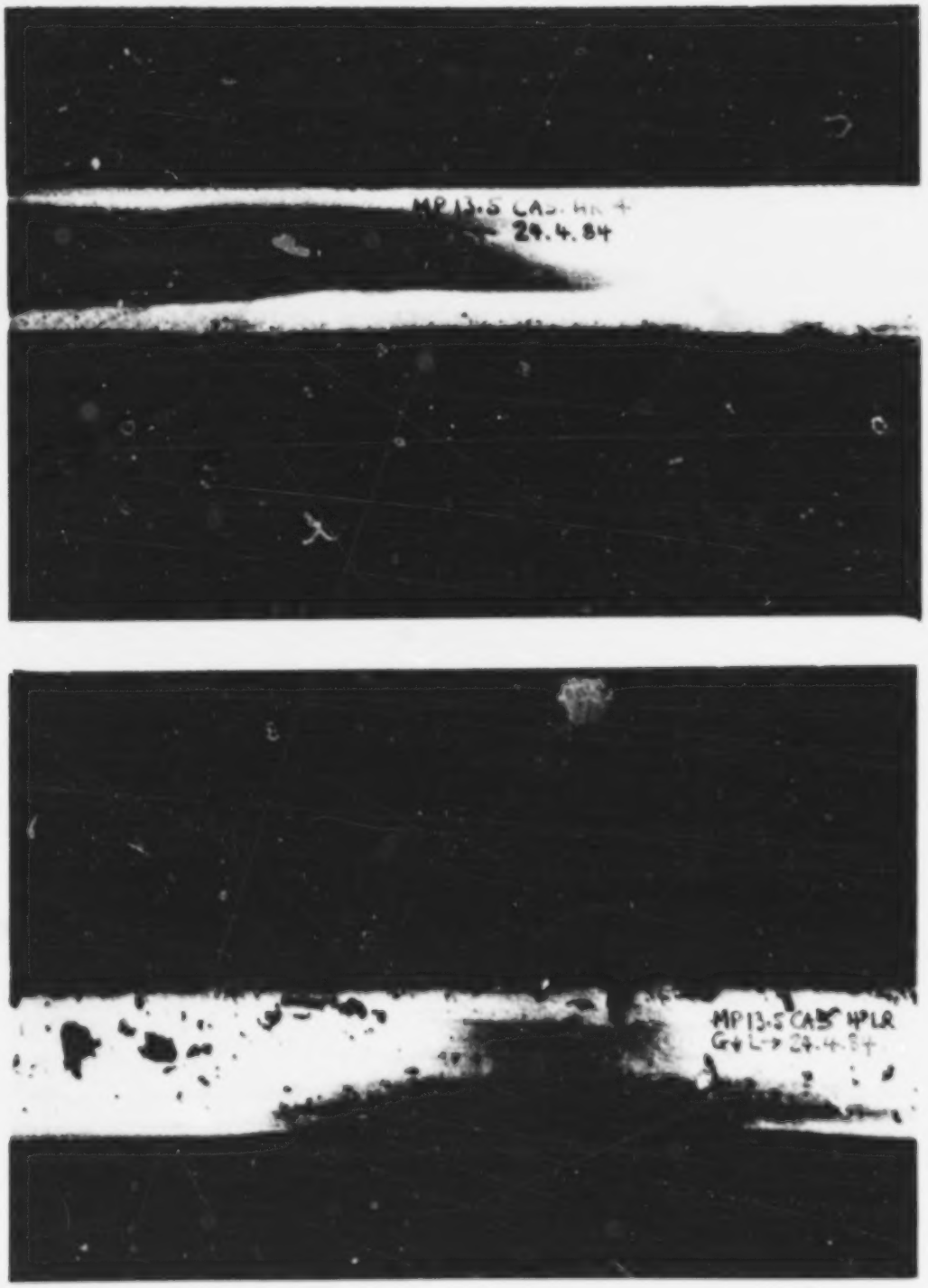
Pregrinding, Curve No. 12, MP 10.0



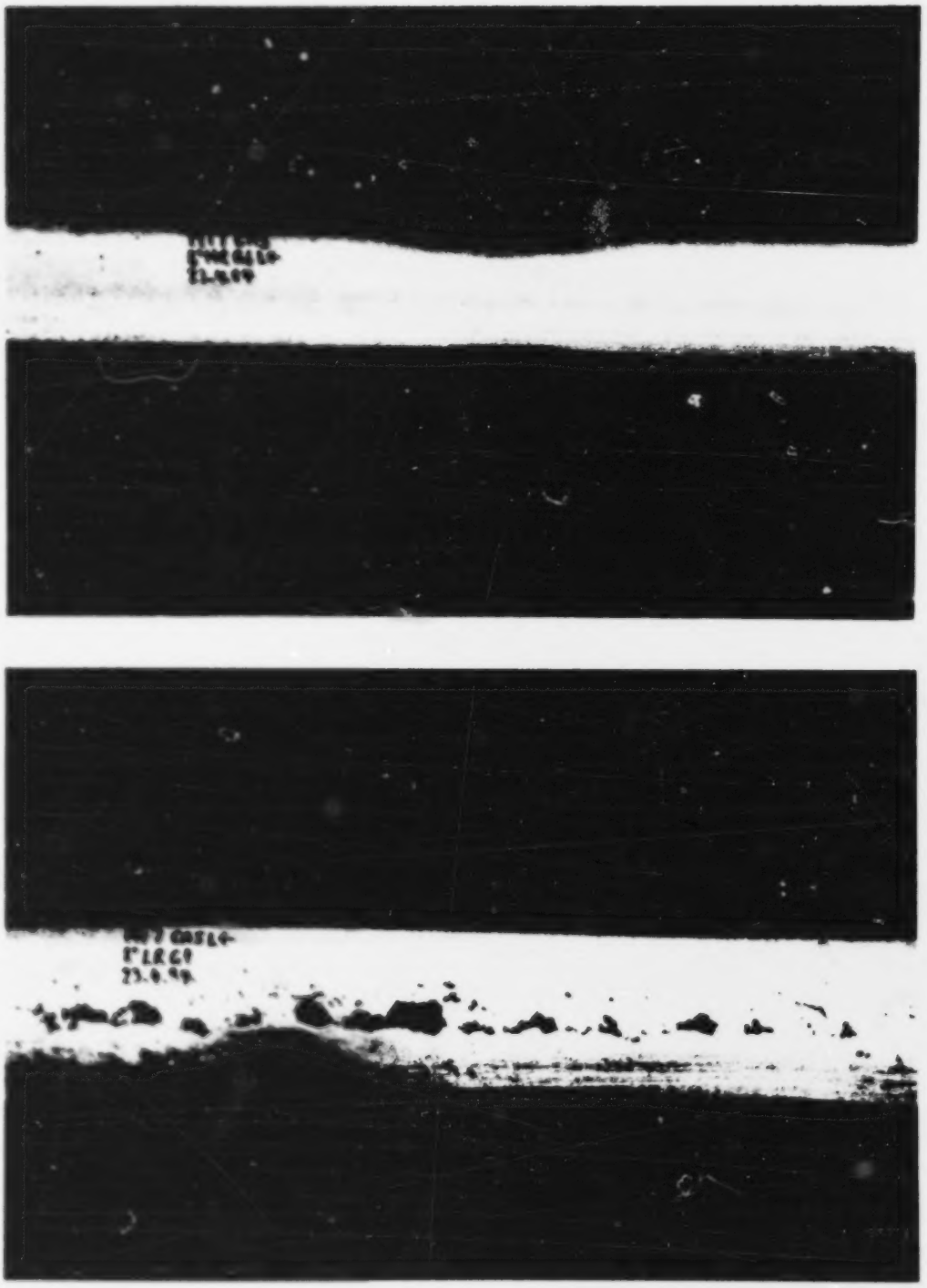
Pregrinding, Curve No. 13, MP 10.6



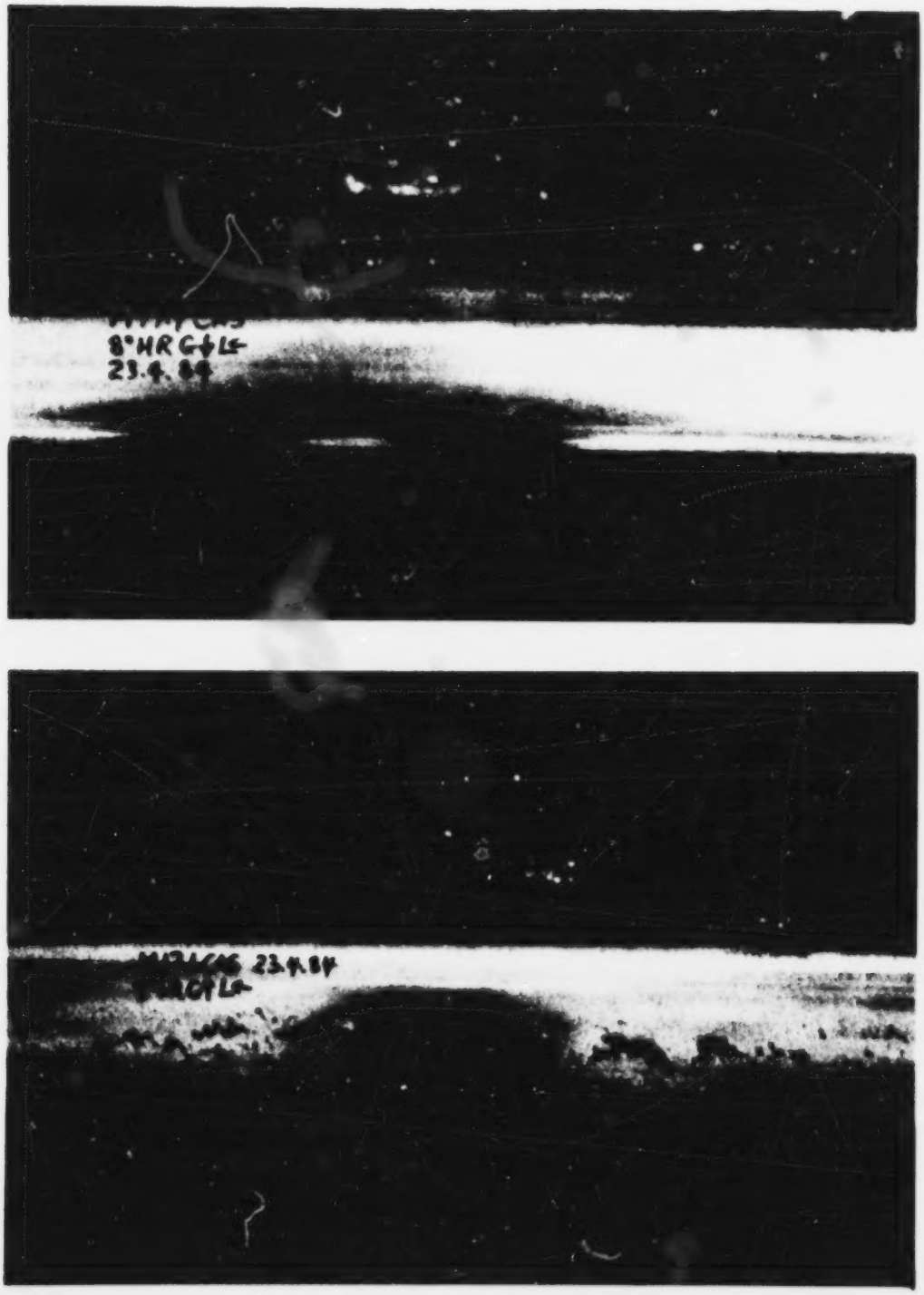
Pregrinding, Curve No. 14, MP 10.5



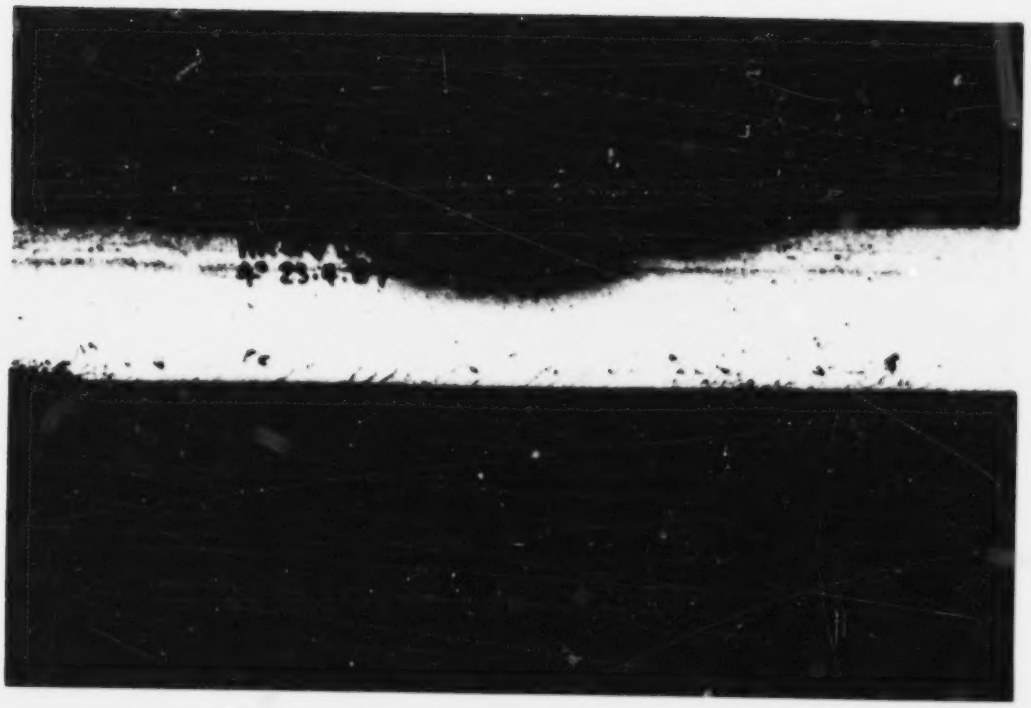
Pregrinding, Curve No. 17, MP 13.5



Pregrinding, Curve No. 19, MP 17.0

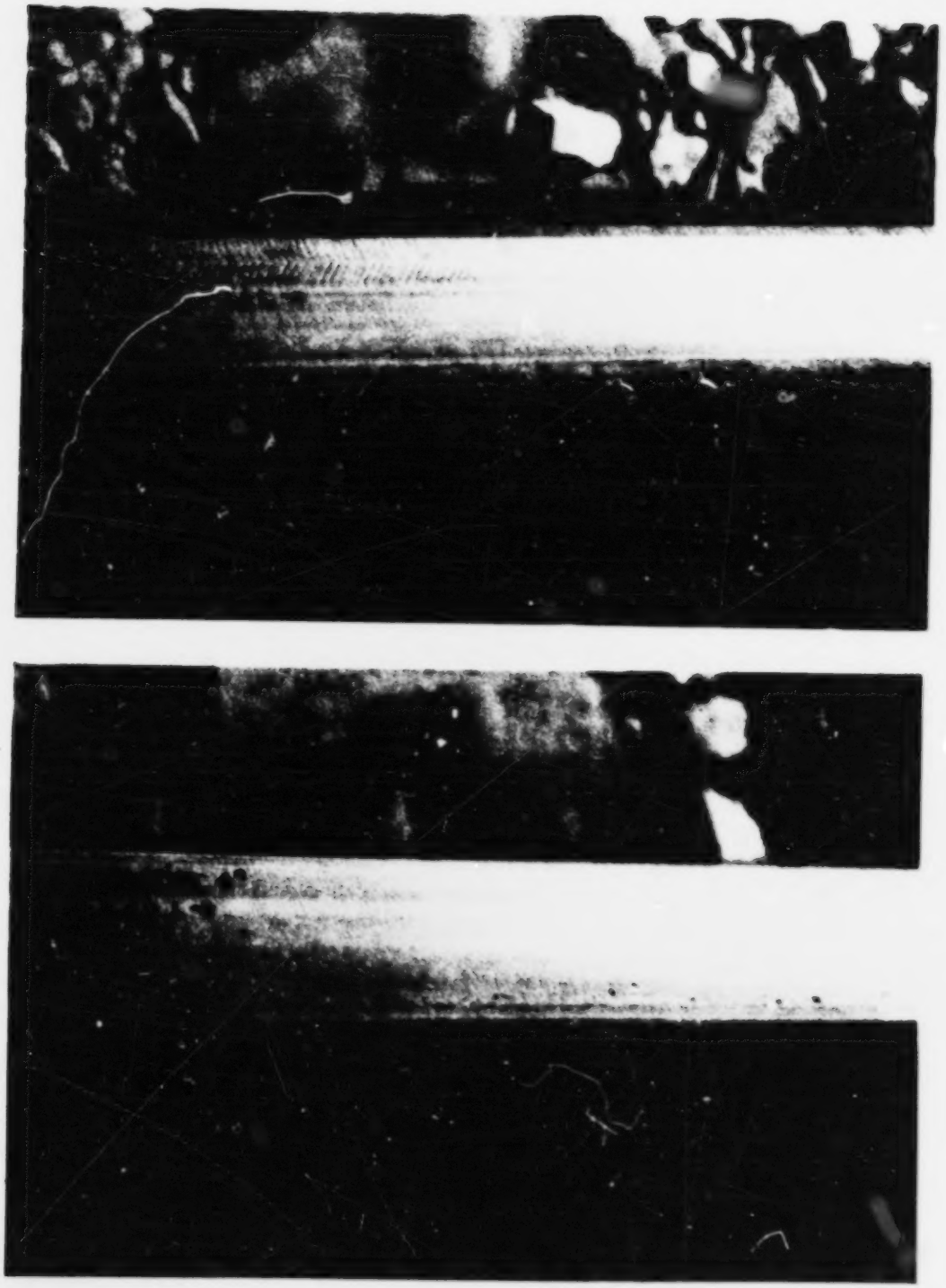


Pregrinding, Curve No. 20, MP 17.1

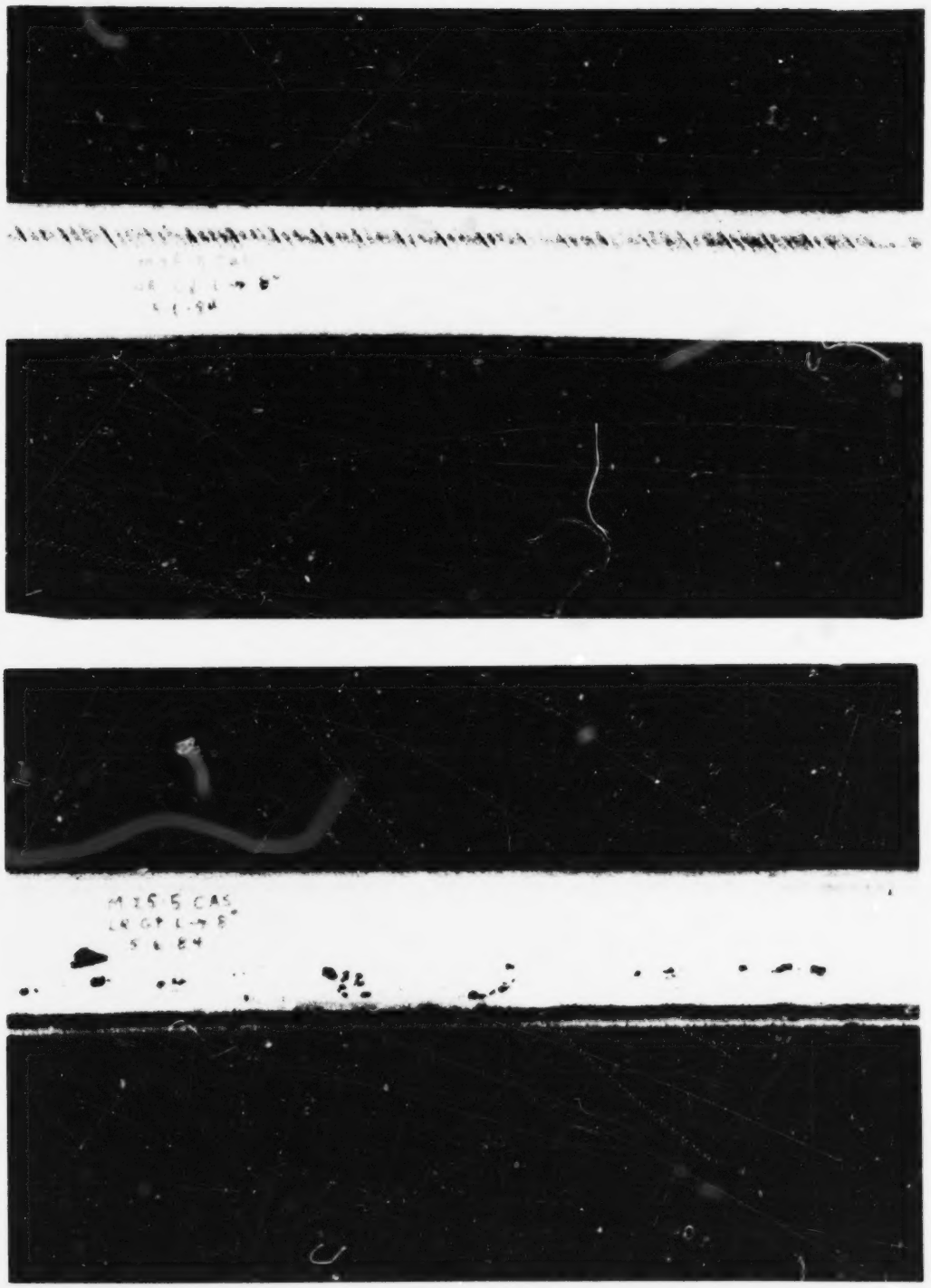


Pregrinding, Curve No. 21, MP 27.0

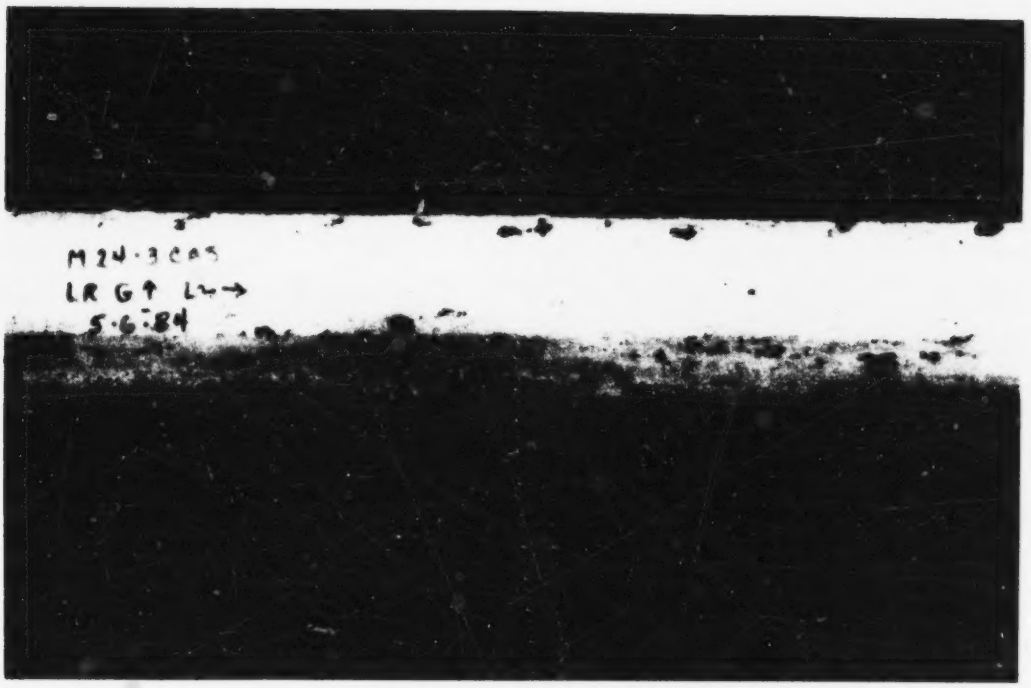
Pregrinding, Curve No. 22, MP 27.3



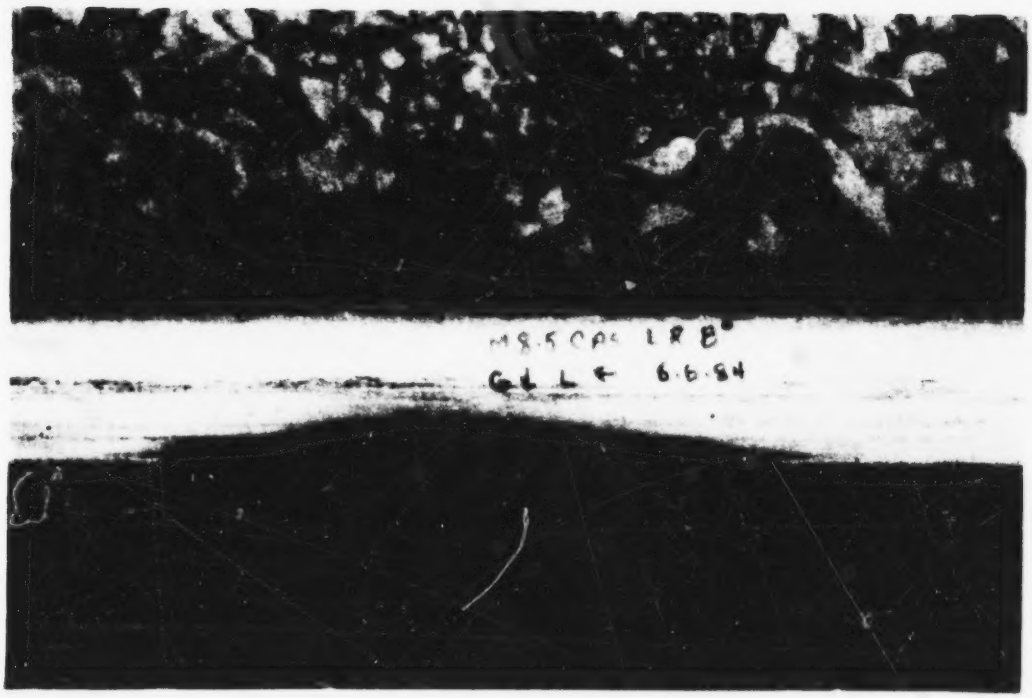
Post-grinding, Curve No. 1, MP 26.0



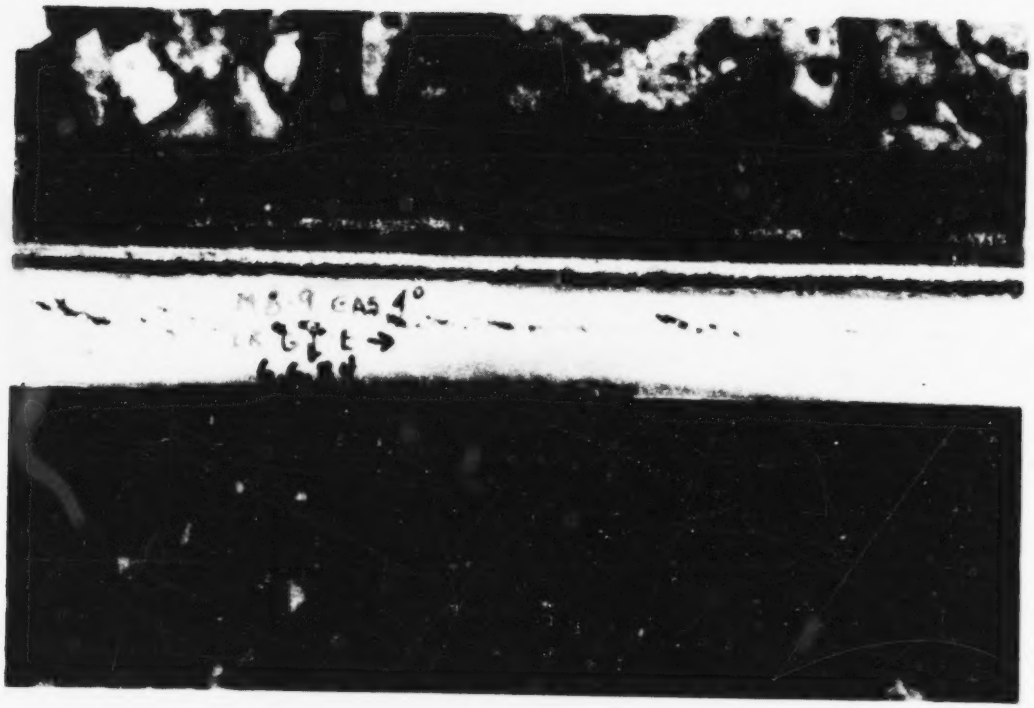
Post-grinding, Curve No. 3, MP 25.5



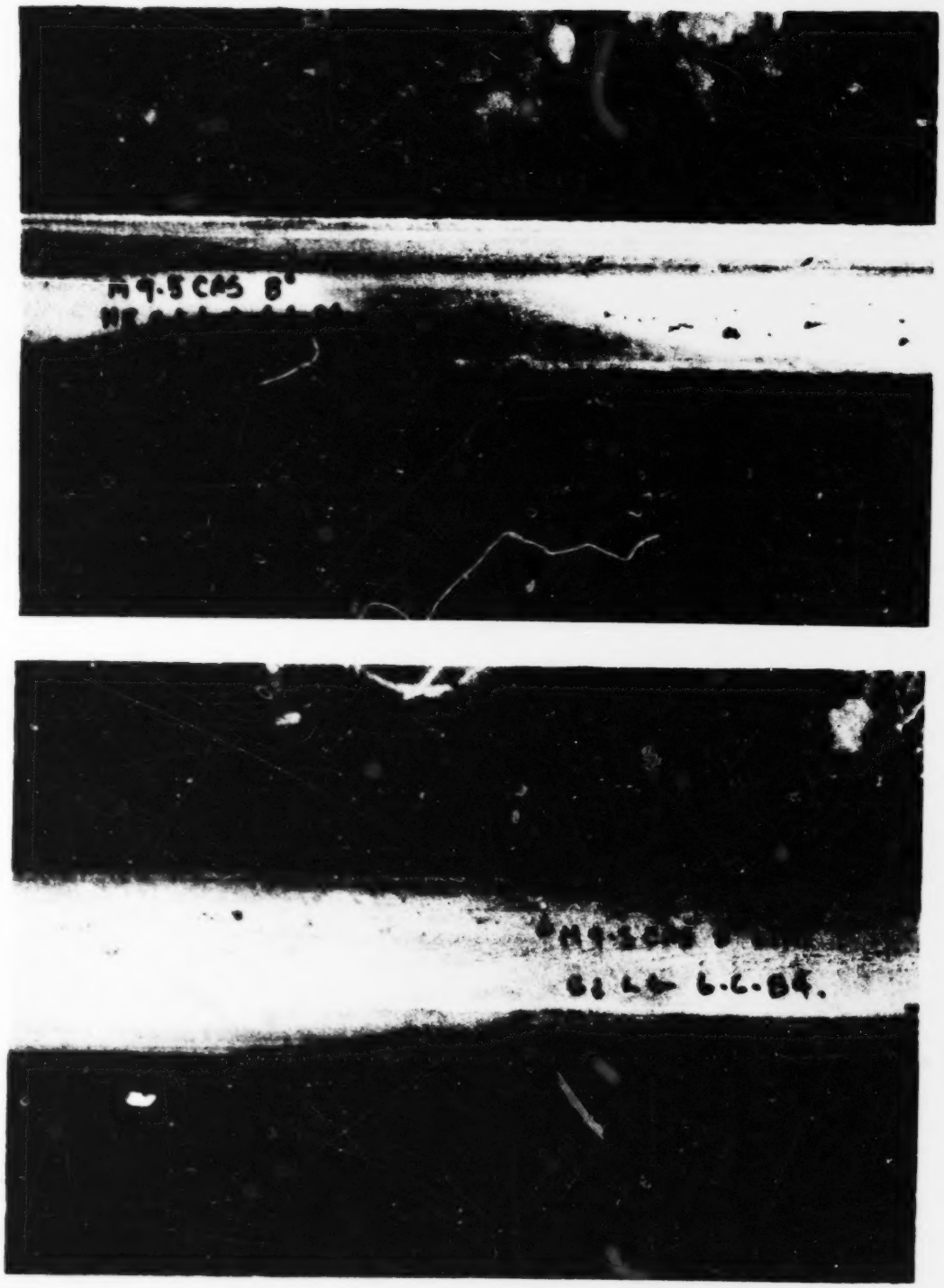
Post-grinding, Curve No. 5, MP 24.3



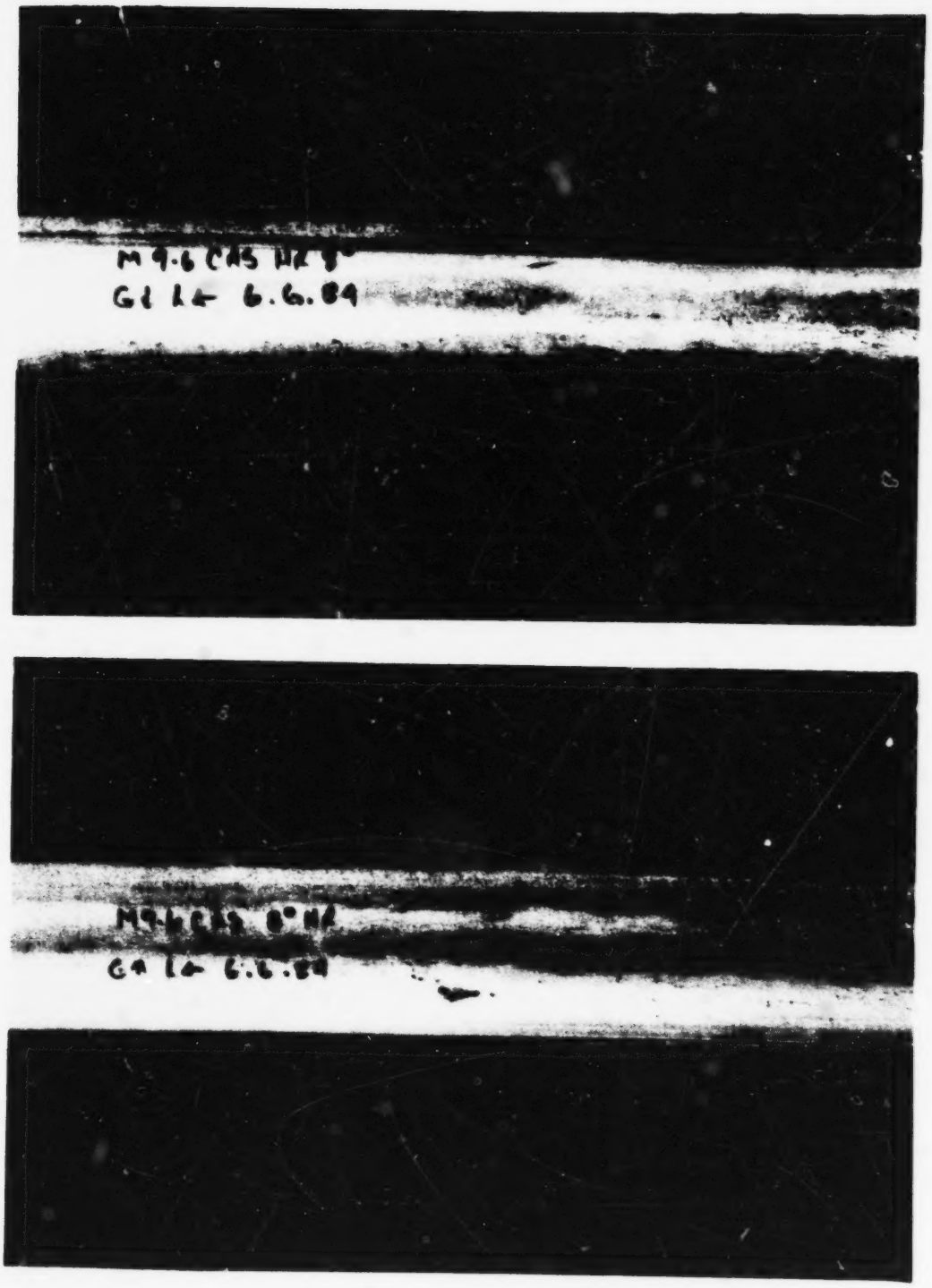
Post-grinding, Curve No. 8, MP 8.5



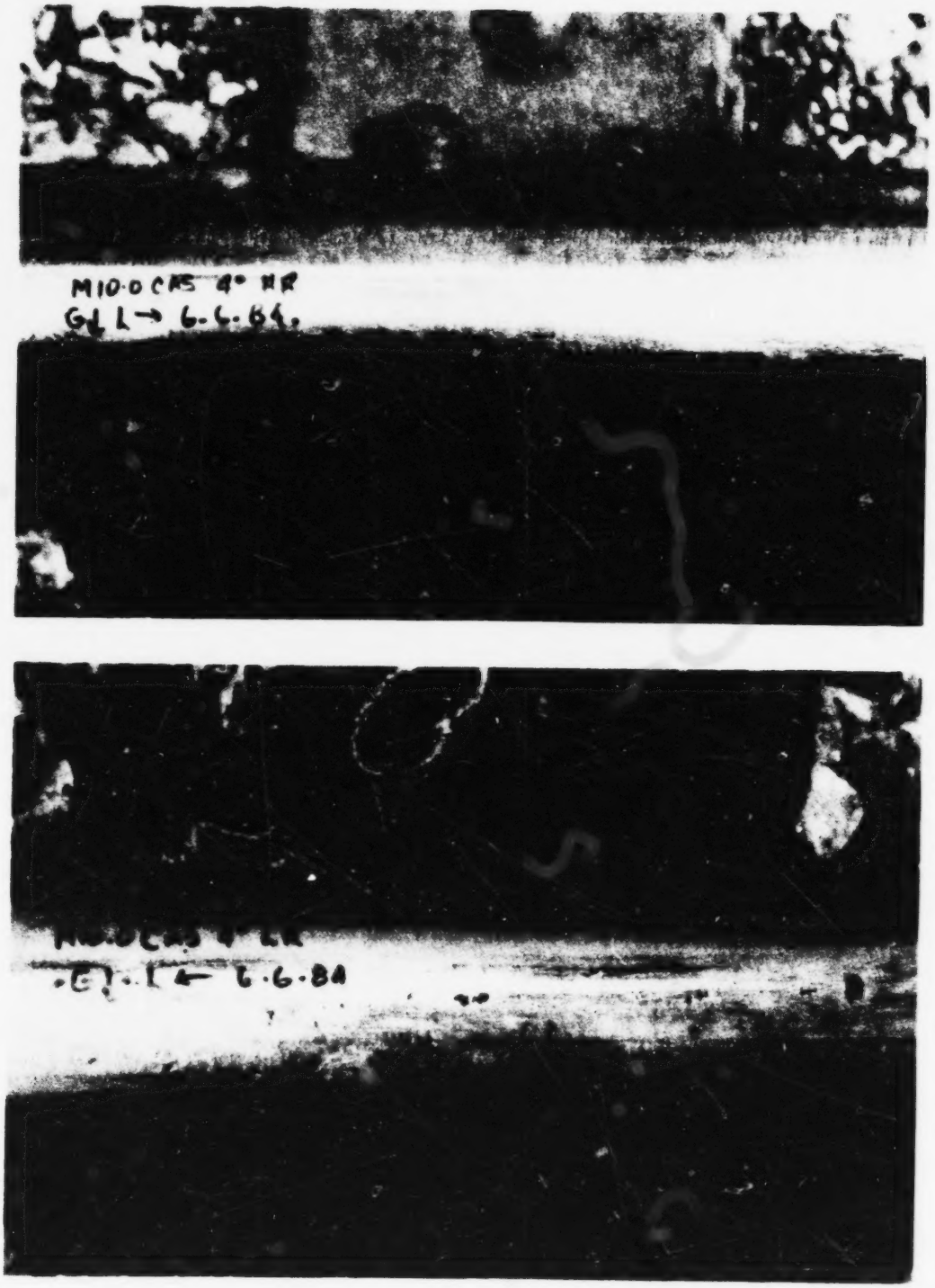
Post-grinding, Curve No. 9, MP 8.9



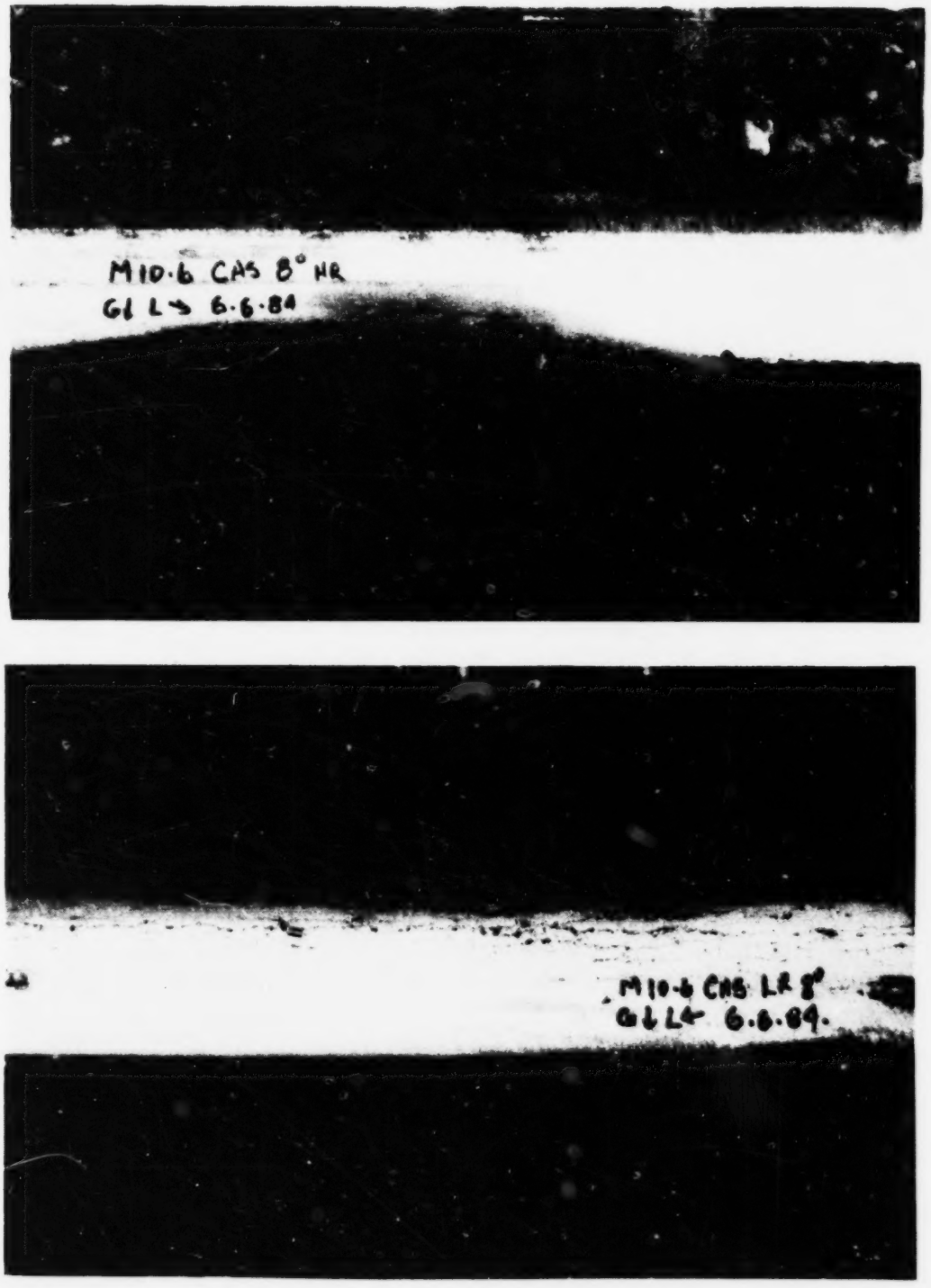
Post-grinding, Curve No. 10, MP 9.5



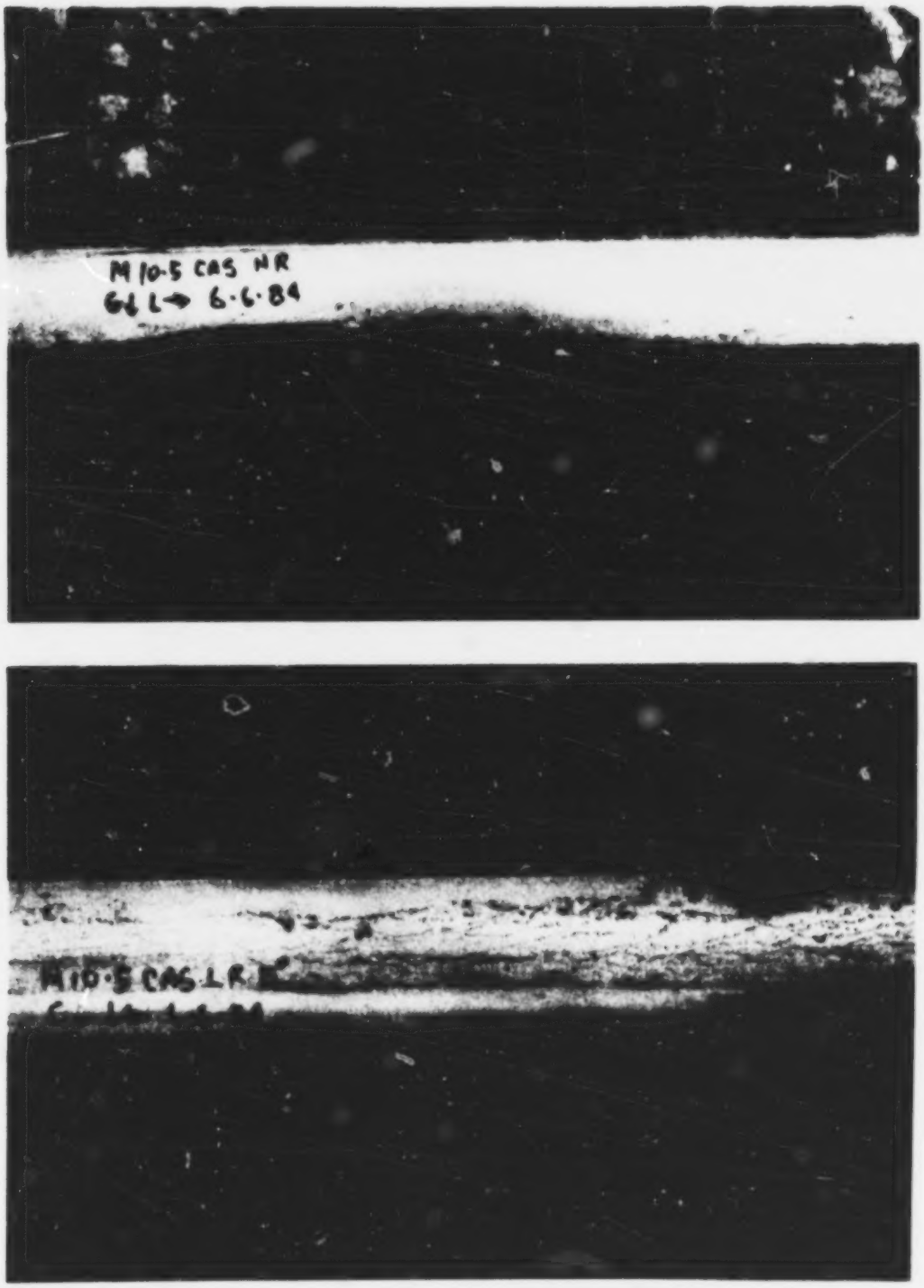
Post-grinding, Curve No. 11, MP 9.6



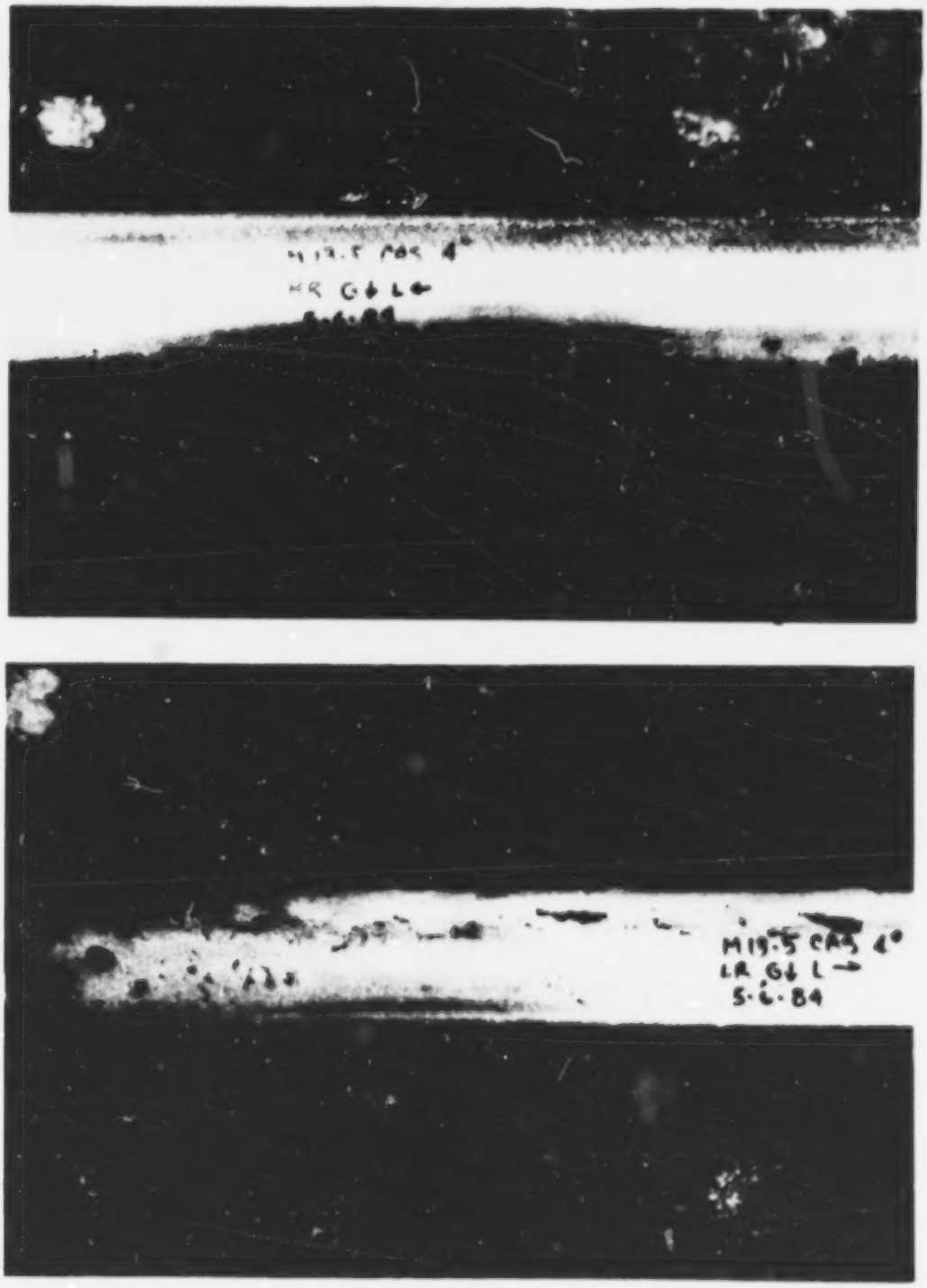
Post-grinding, Curve No. 12, MP 10.0



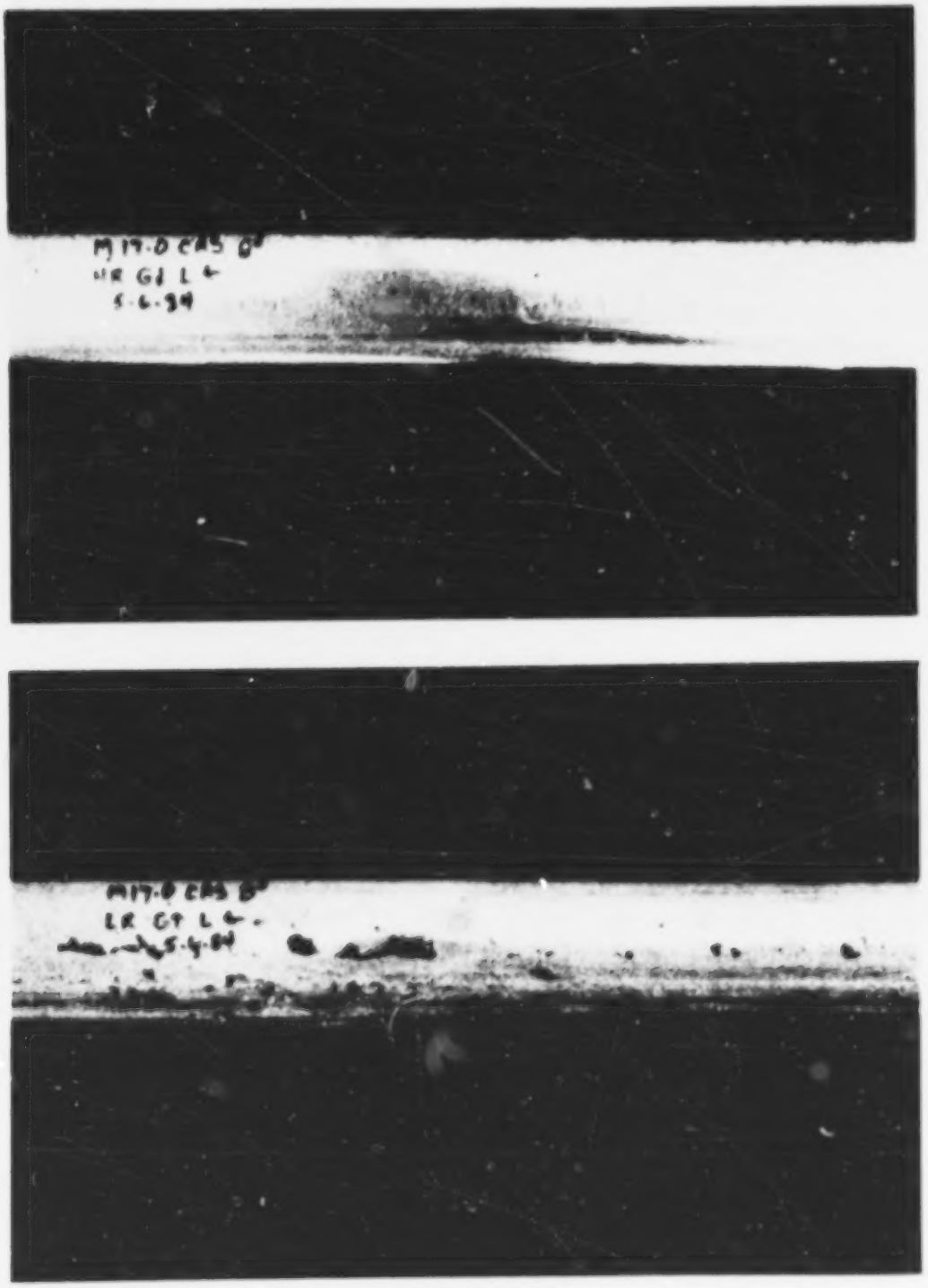
Post-grinding, Curve No. 13, MP 10.6



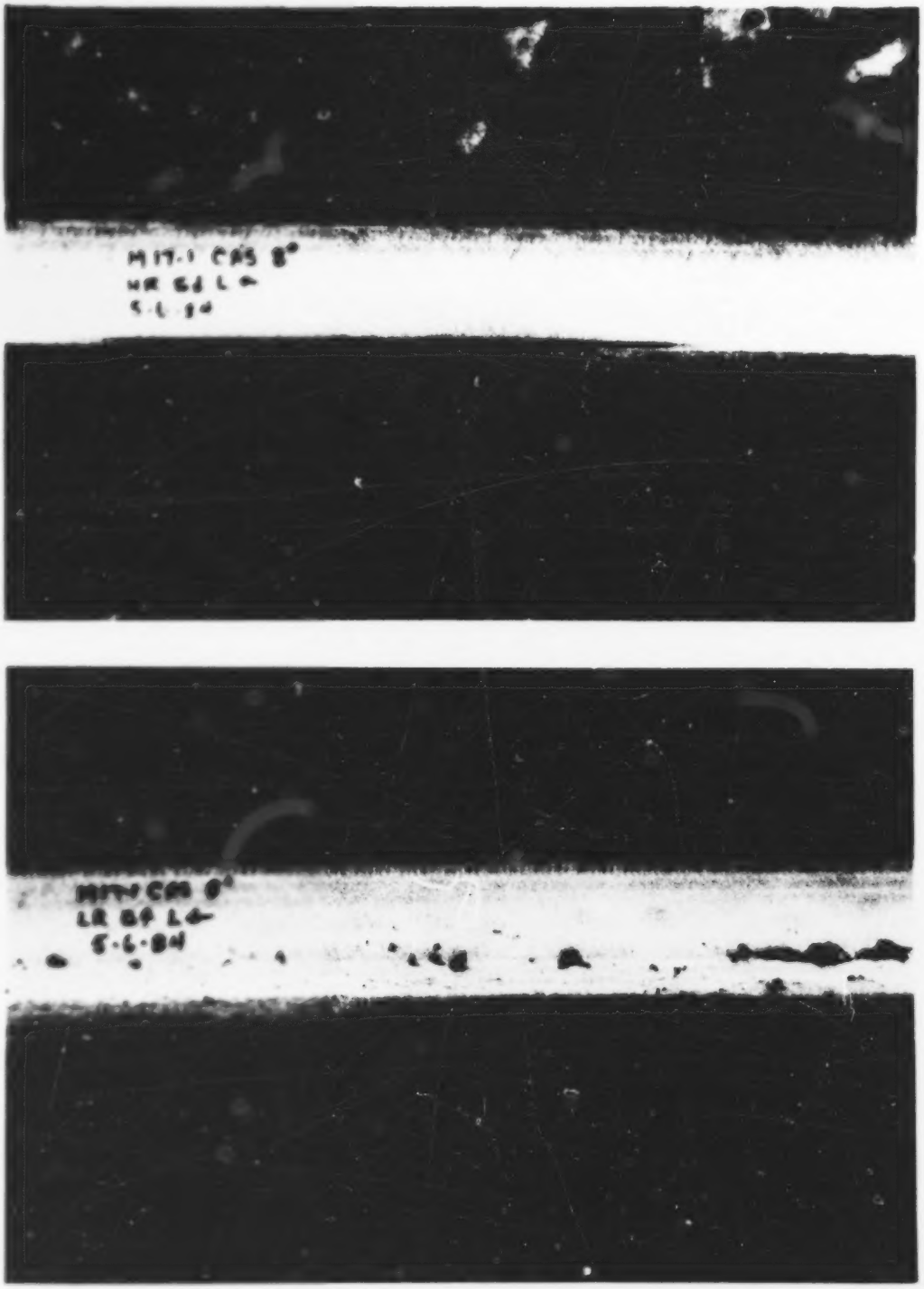
Post-grinding, Curve No. 14, MP 10.5



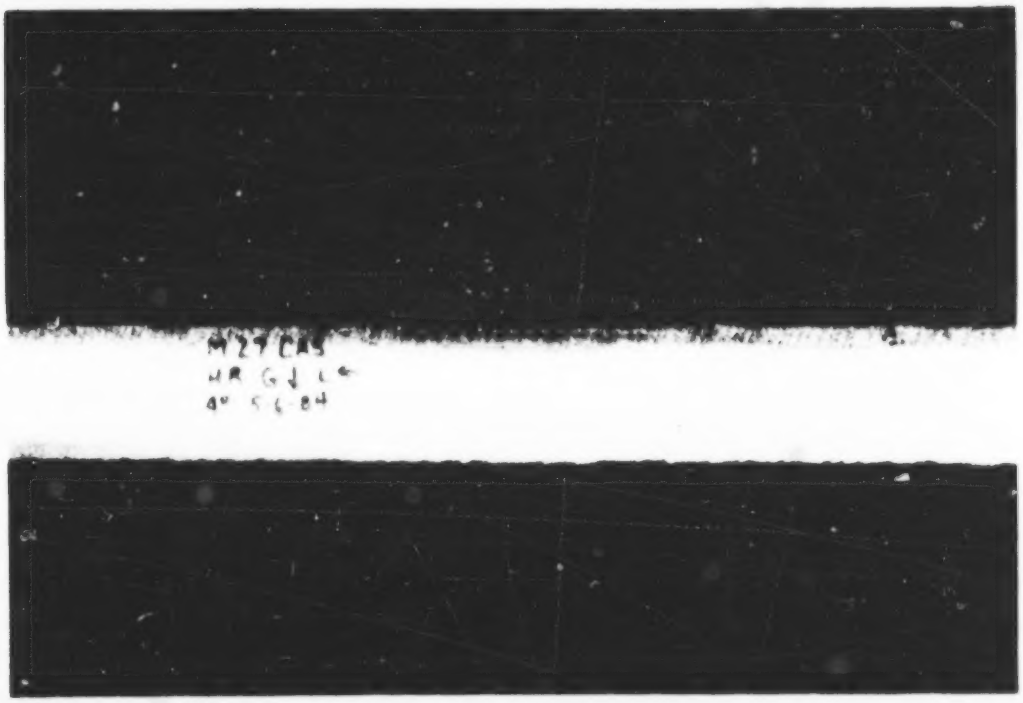
Post-grinding, Curve No. 17, MP 13.5



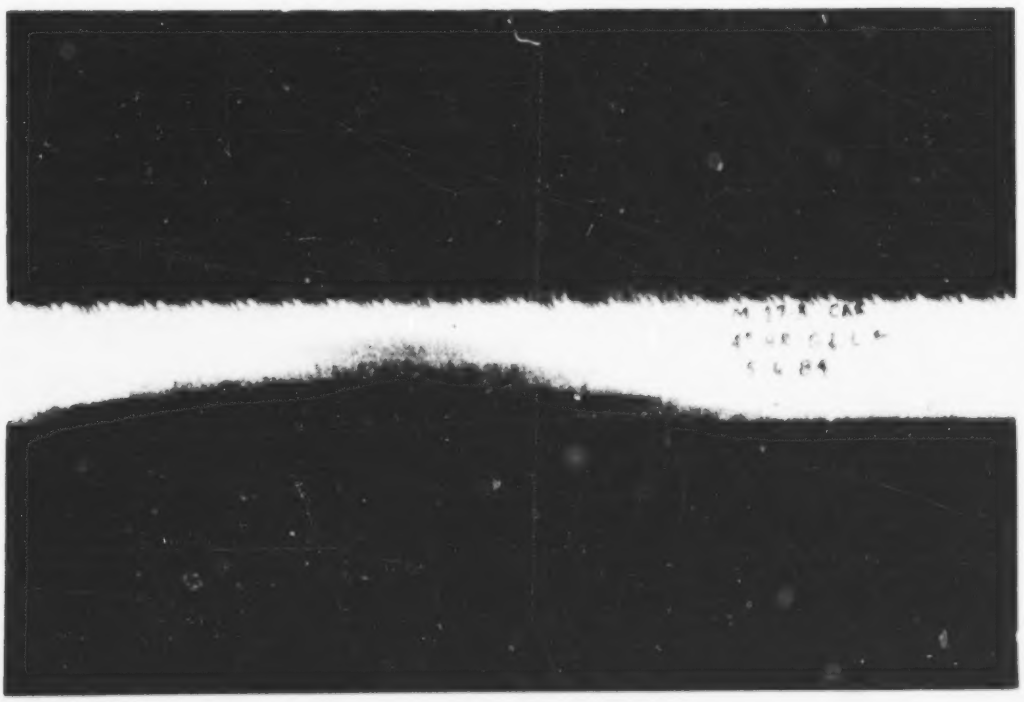
Post-grinding, Curve No. 19, MP 17.0



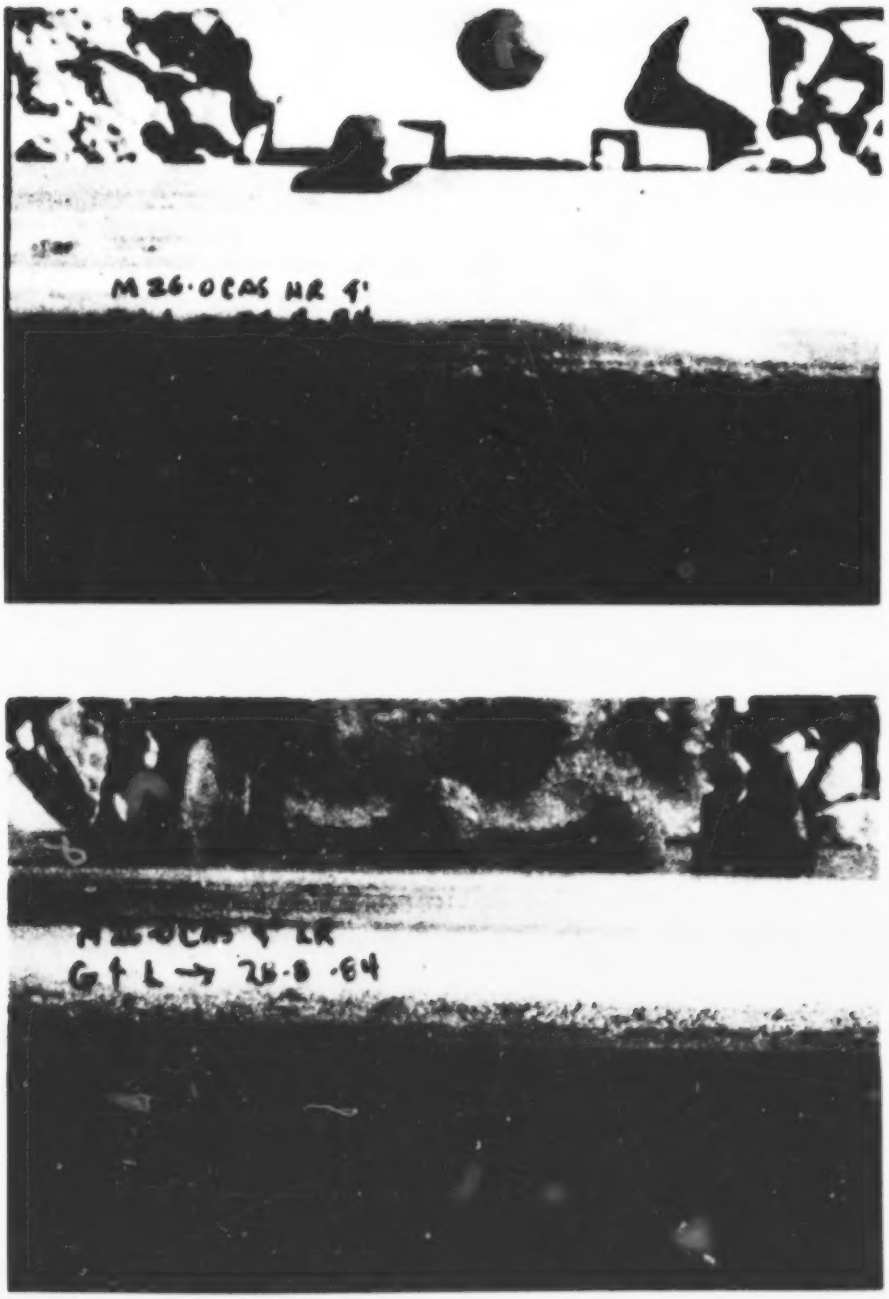
Post-grinding, Curve No. 20, MP 17.1



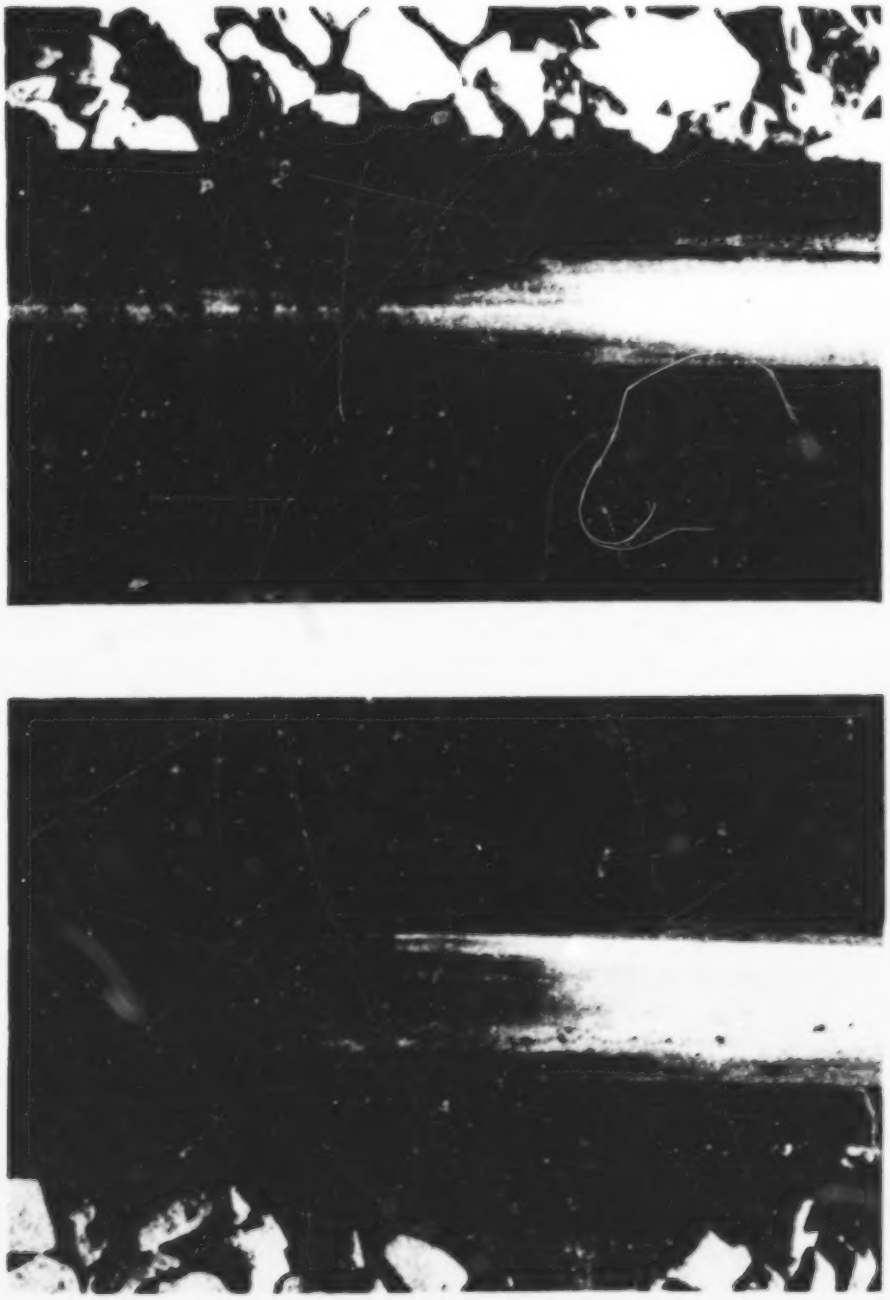
Post-grinding, Curve No. 21, MP 27.0



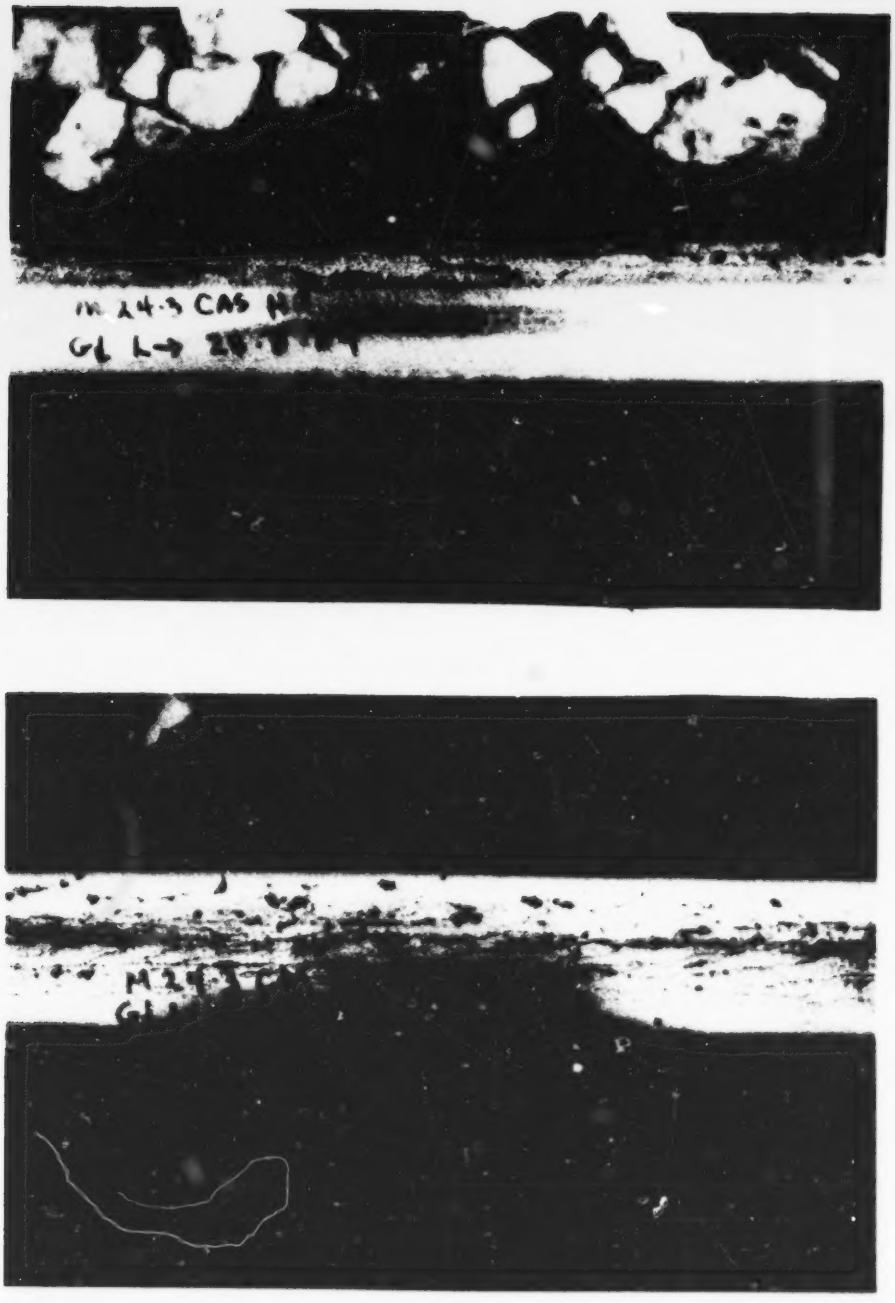
Post-grinding, Curve No. 22, MP 27.3



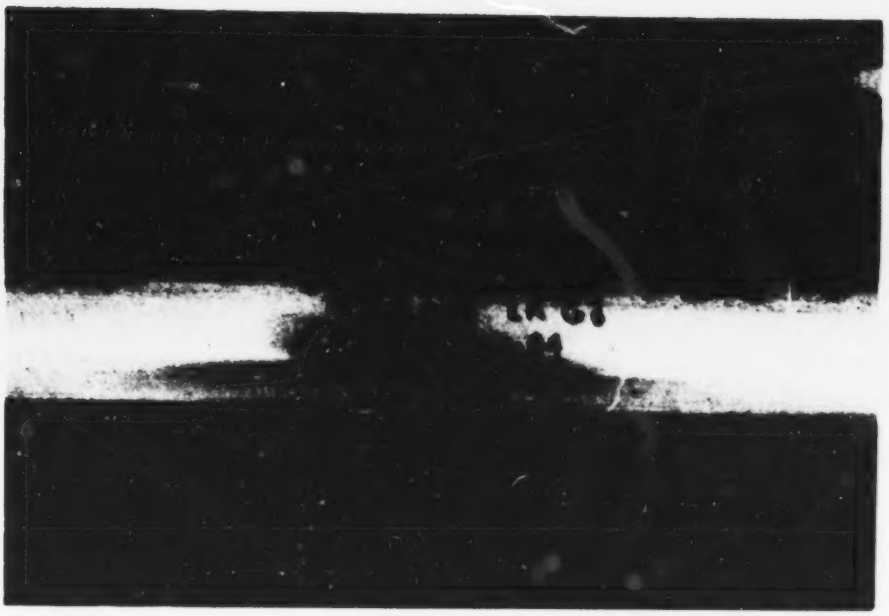
After three months, Curve No. 1, MP 26.0



After three months, Curve No. 3, MP 25.5

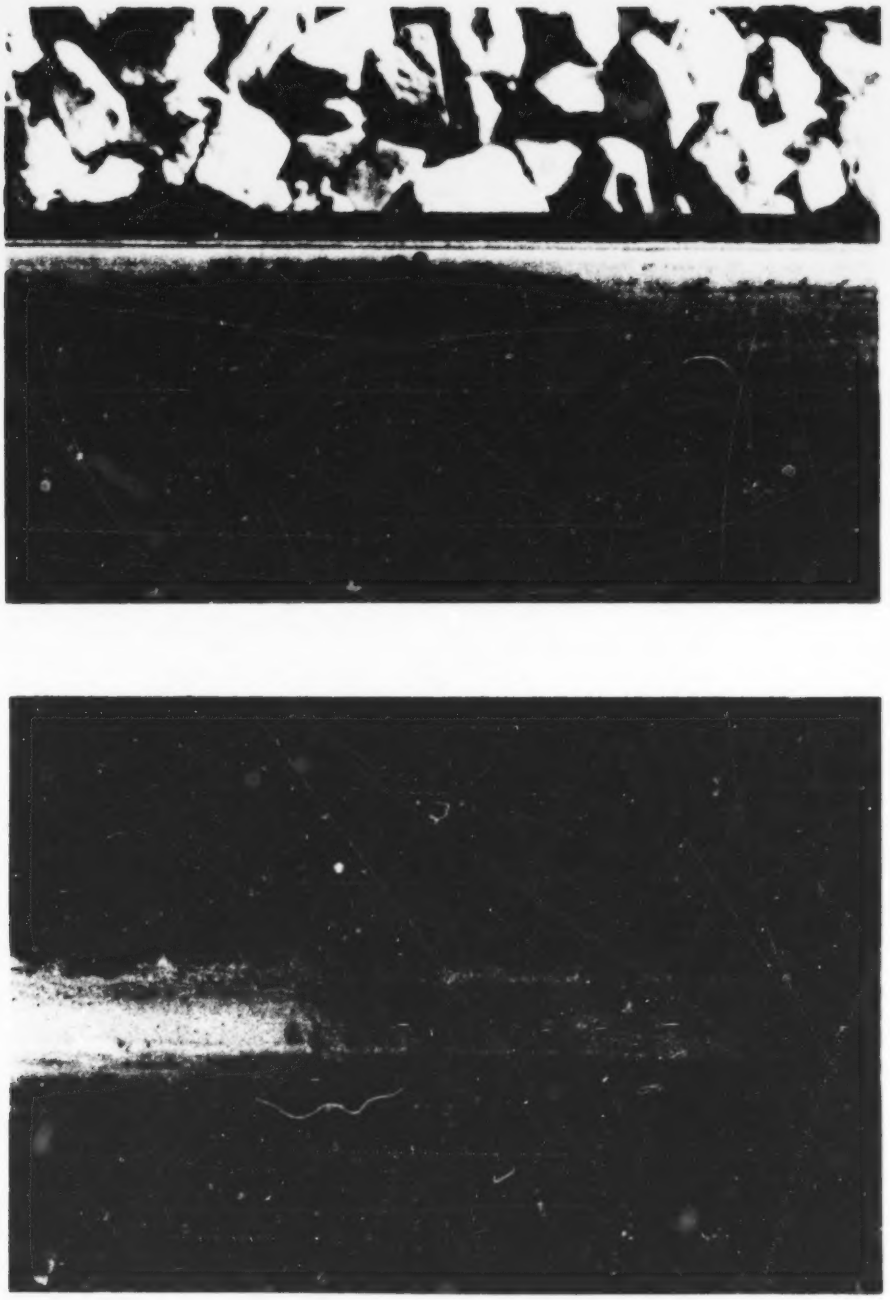


After three months, Curve No. 5, MP 24.3

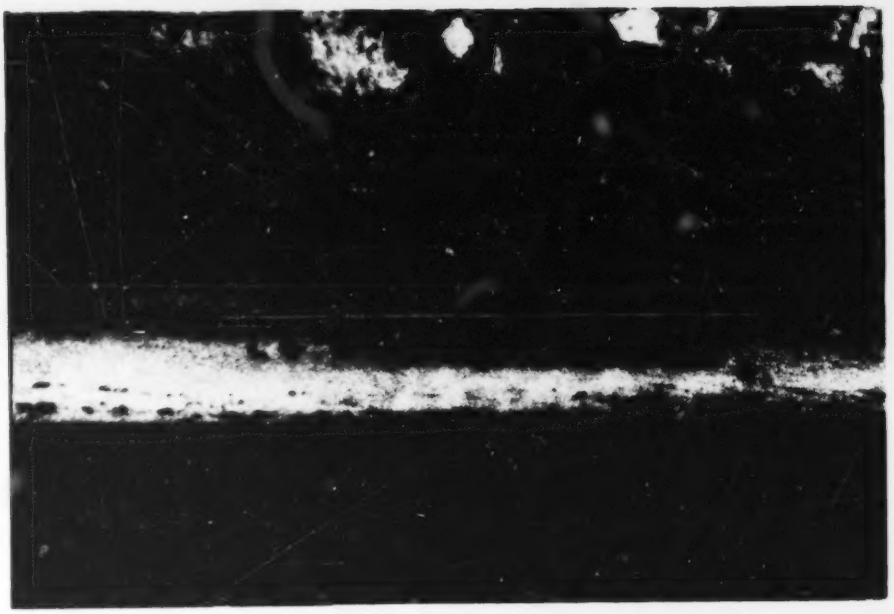


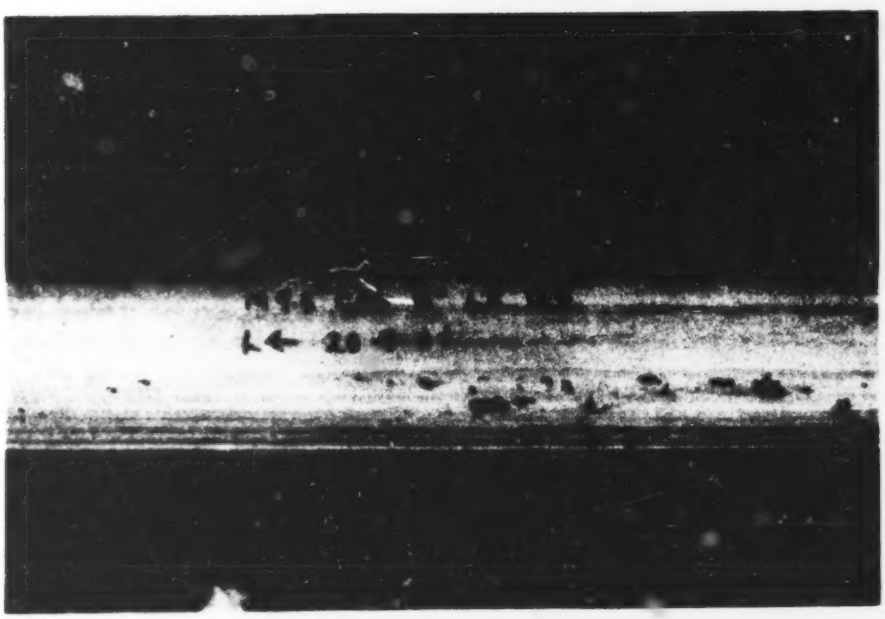
After three months, Curve NO. 8, MP 8.5

After three months, Curve No. 9, MP 8.9

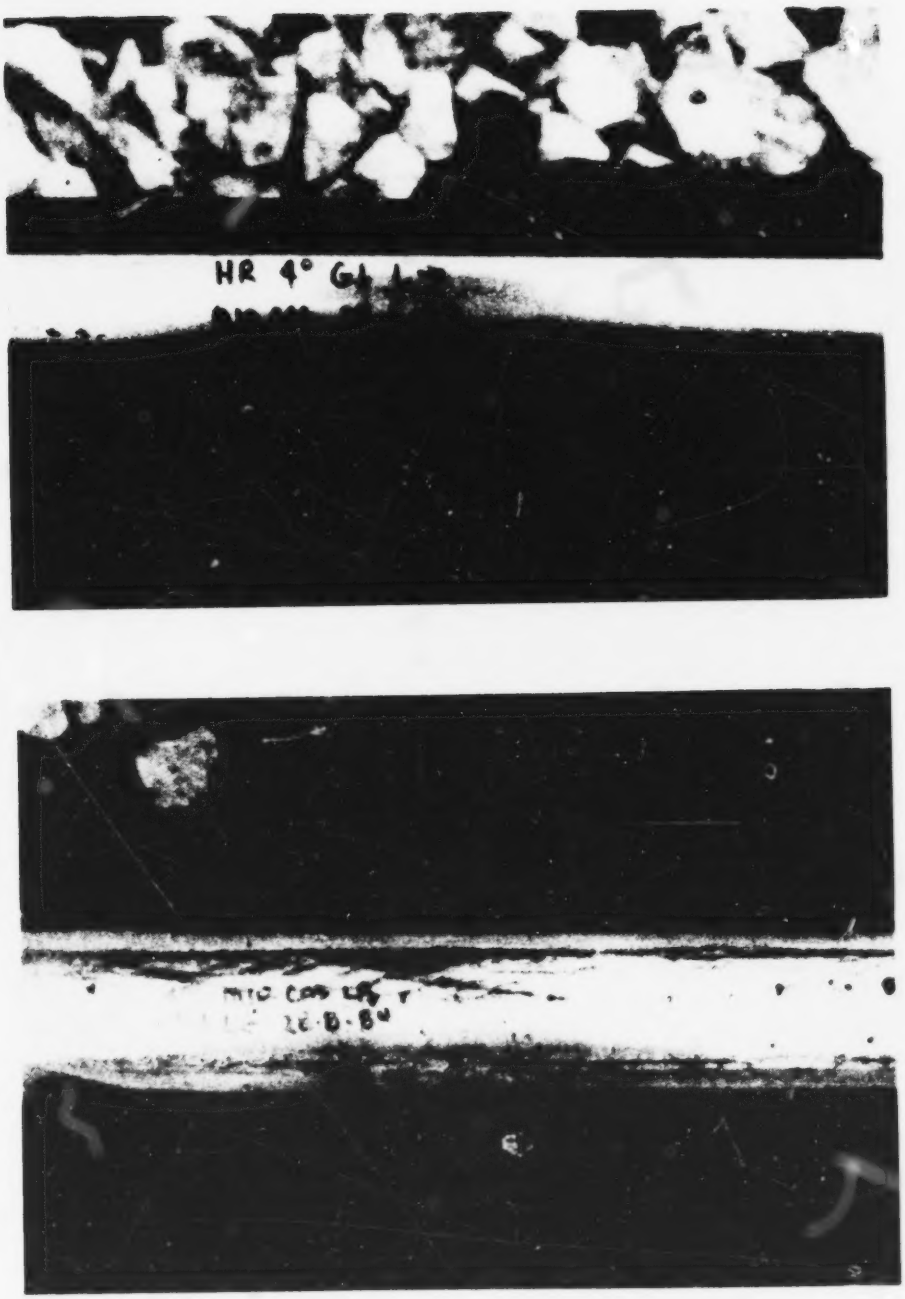


After three months, Curve No. 10, MP 9.5

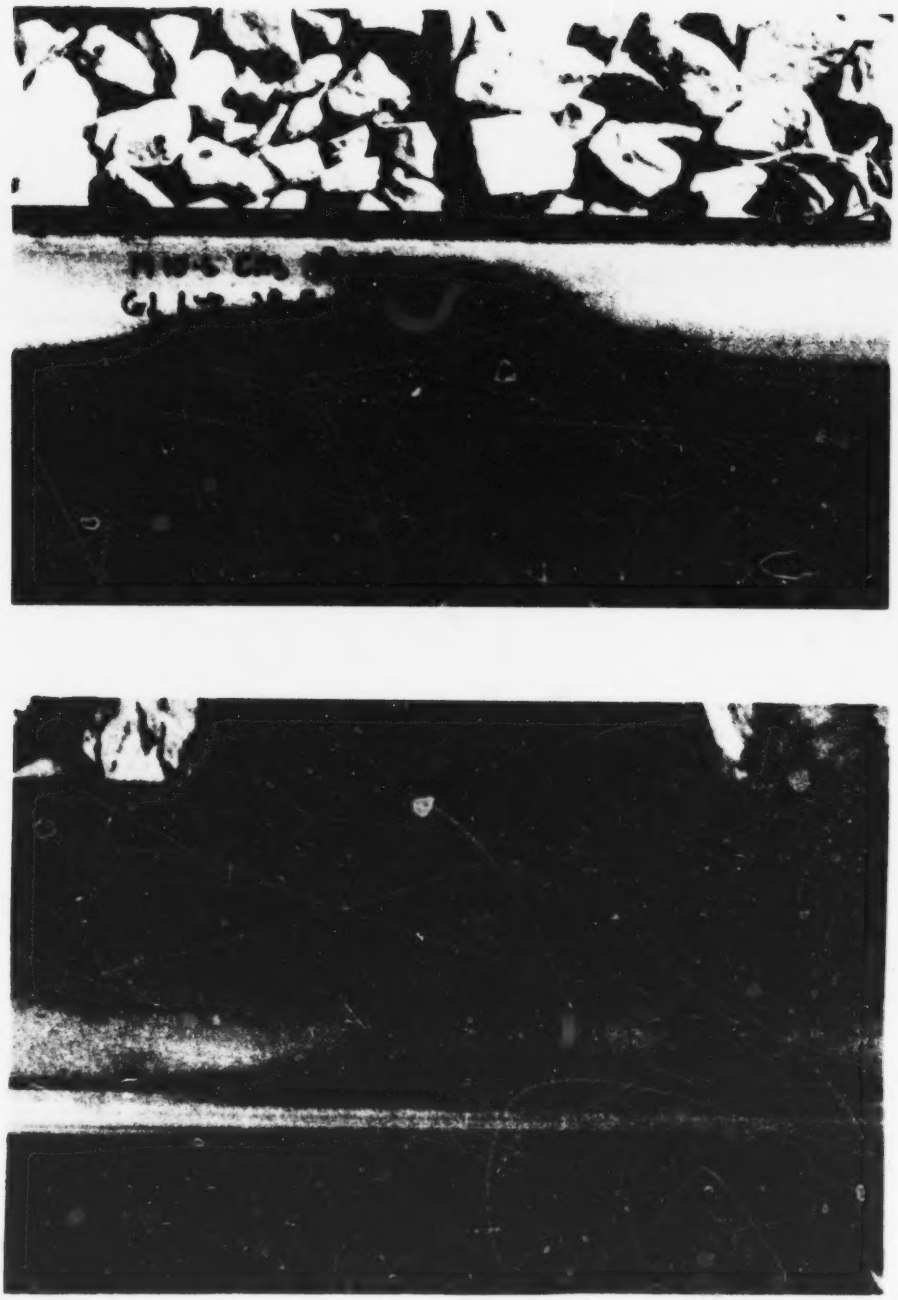




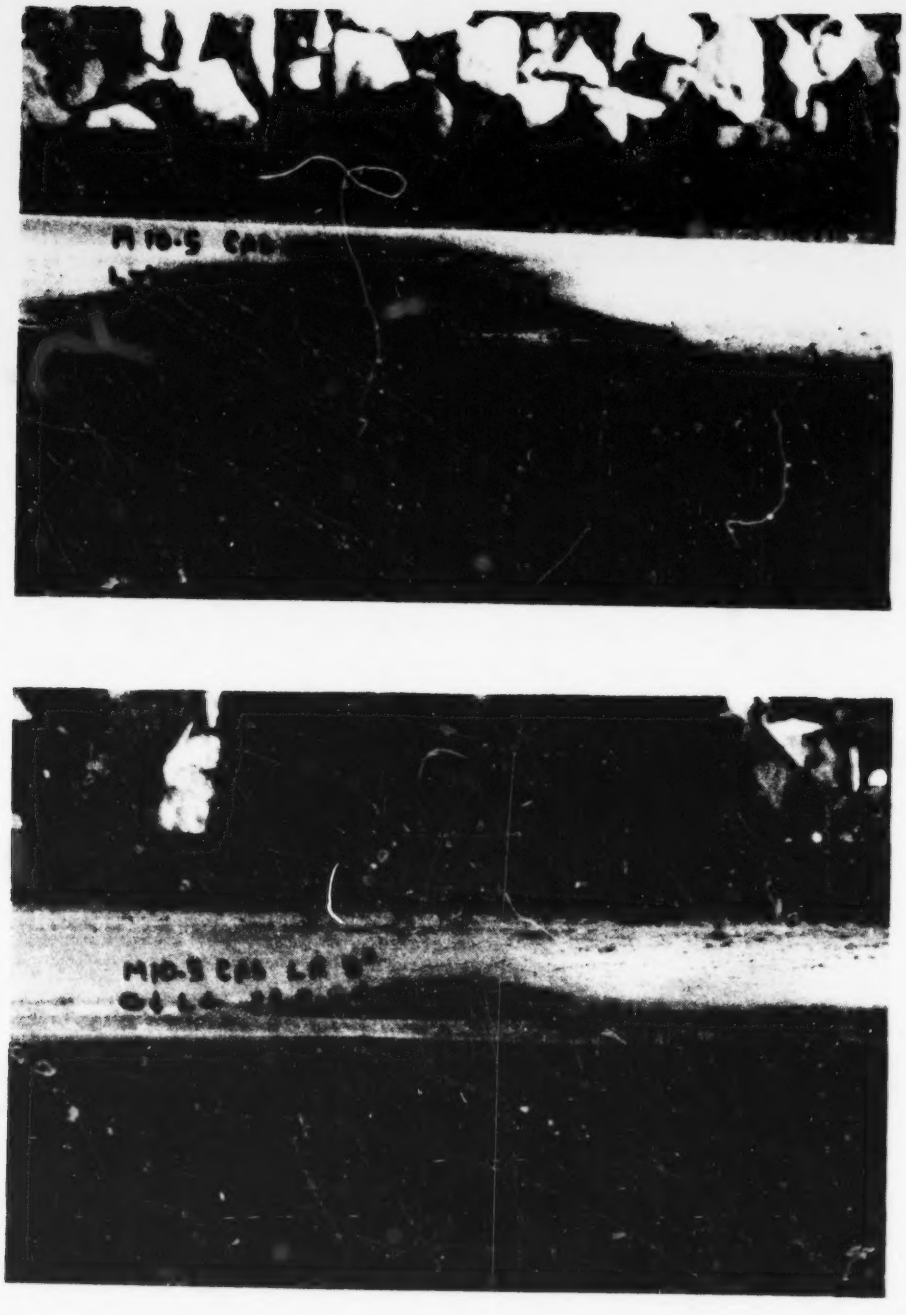
After three months, Curve No. 11, MP 9.6



After three months, Curve No. 12, MP 10.0

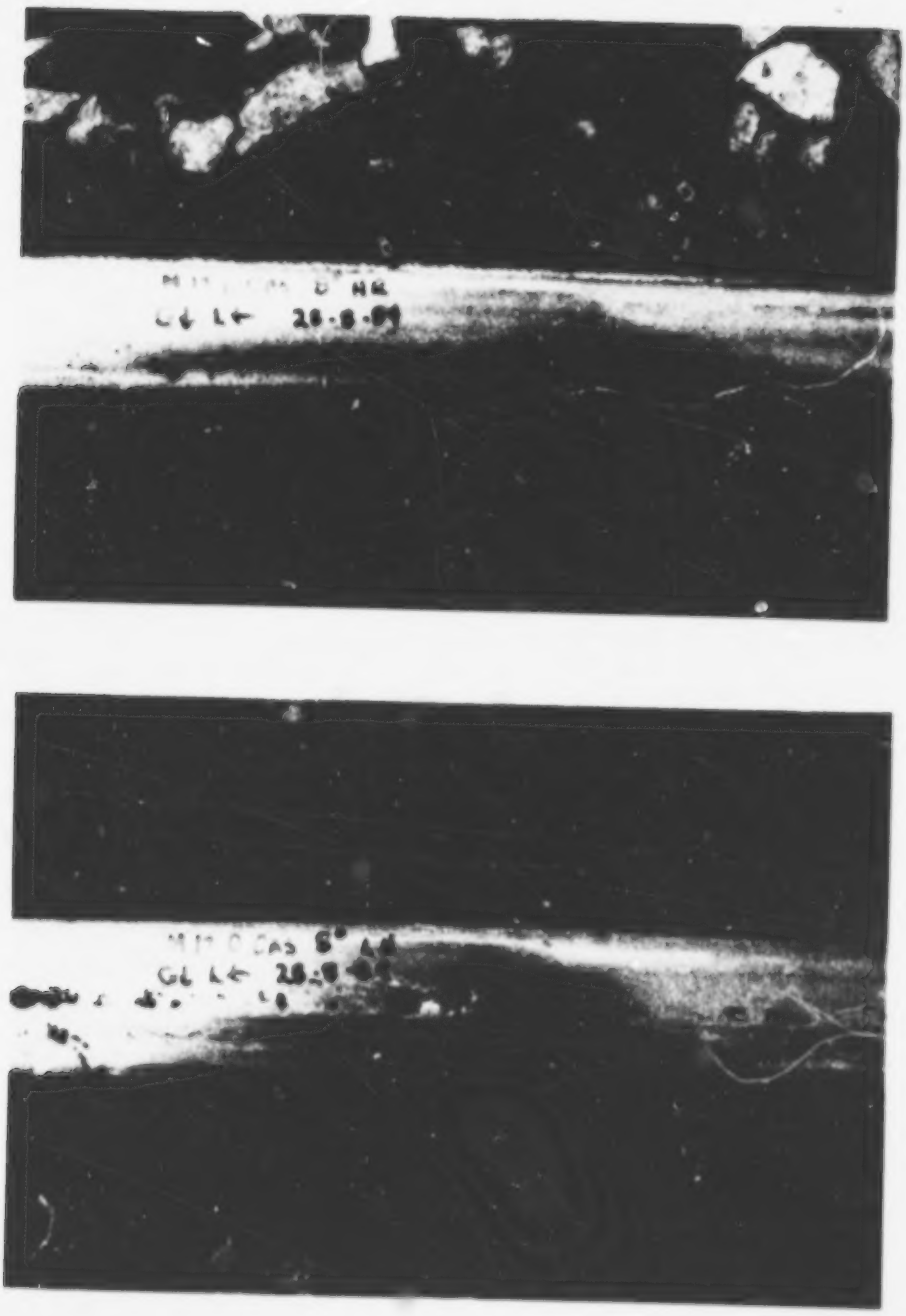


After three months, Curve No. 13, MP 10.6

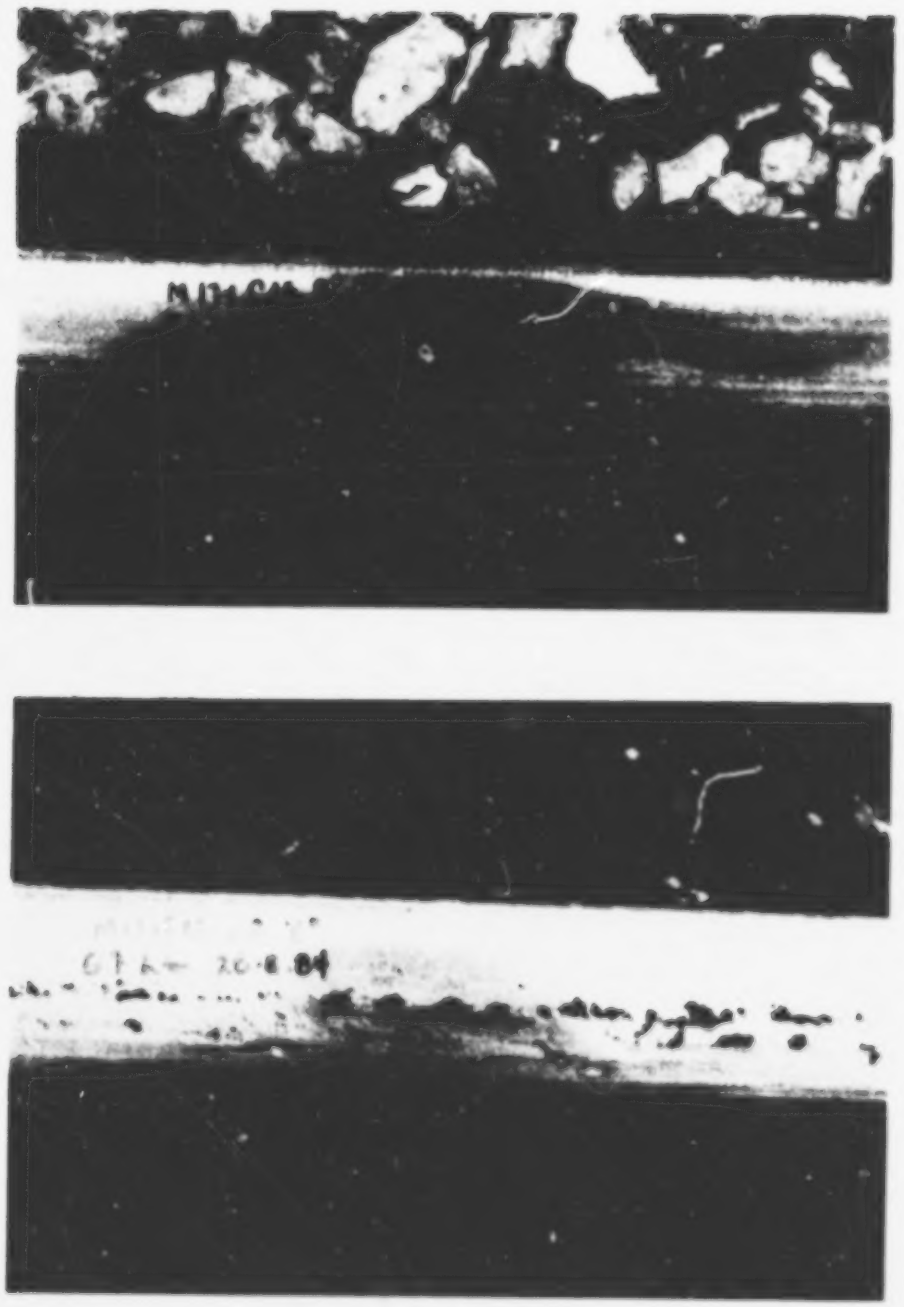


After three months, Curve No. 14, MP 10.5

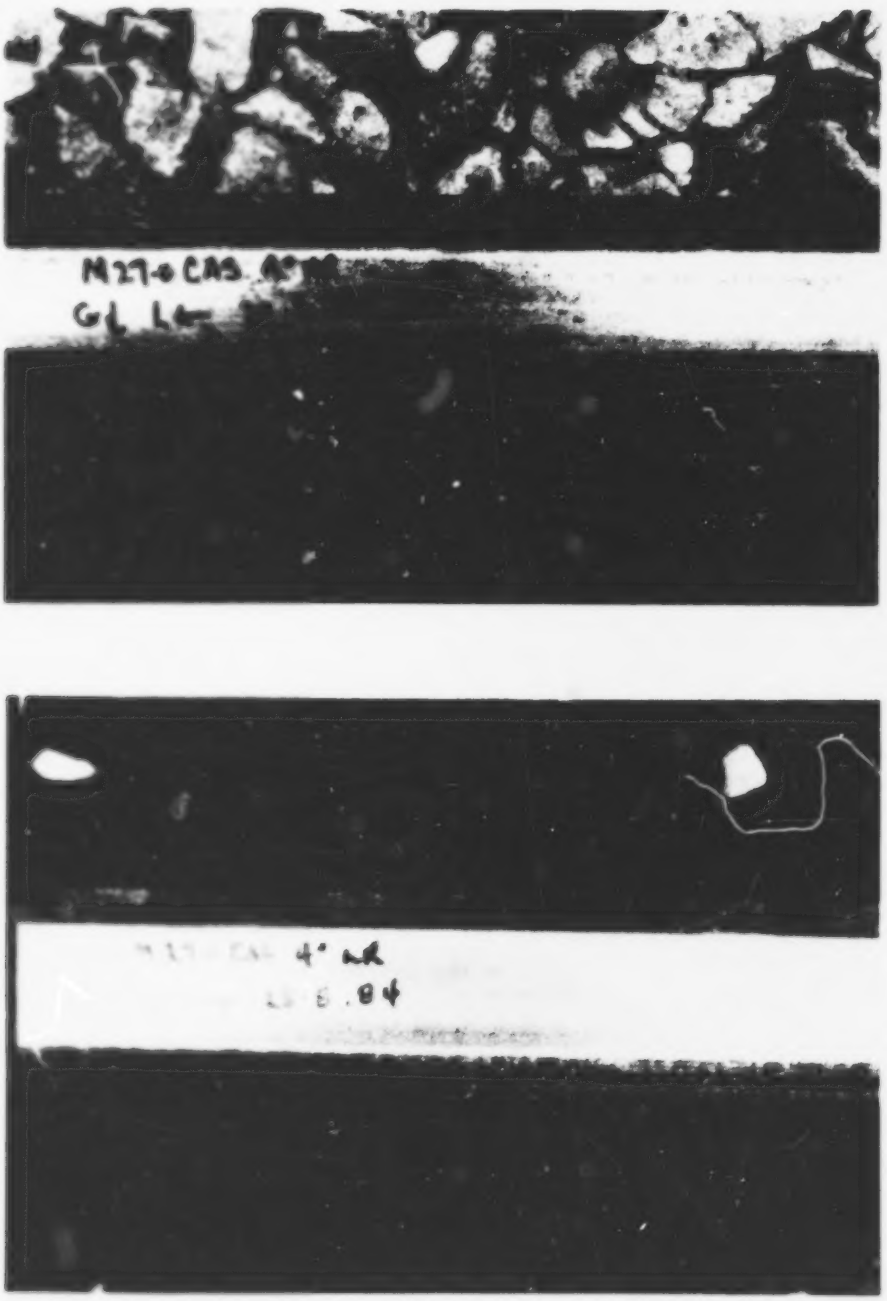
After three months, Curve No. 17, MP 13.5



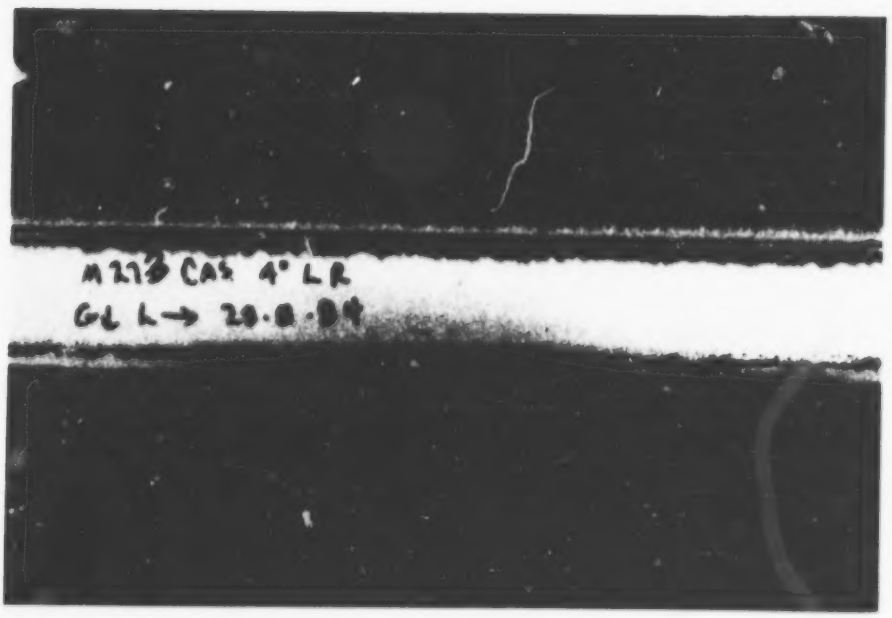
After three months, Curve NO. 19, MP 17.0



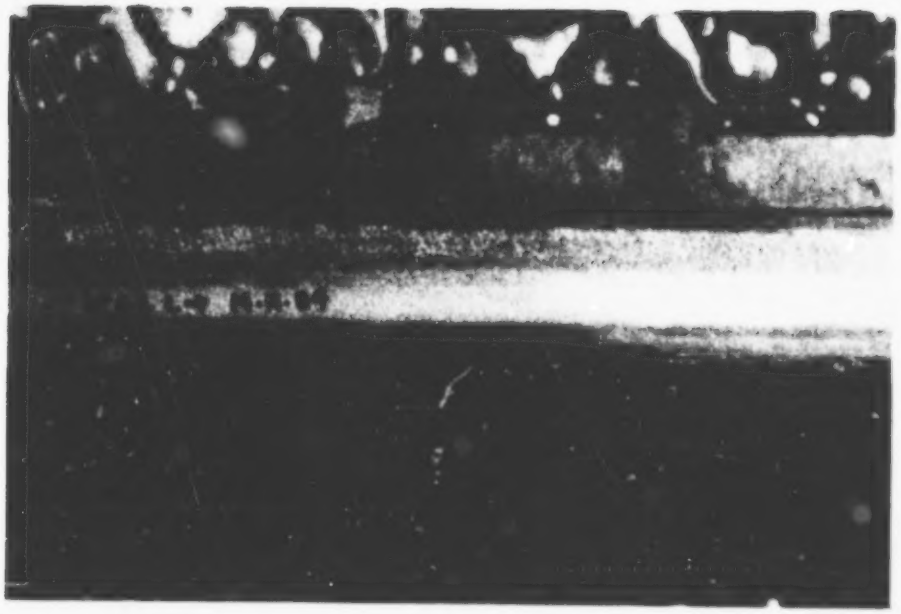
After three months, Curve No. 20, MP 17.1

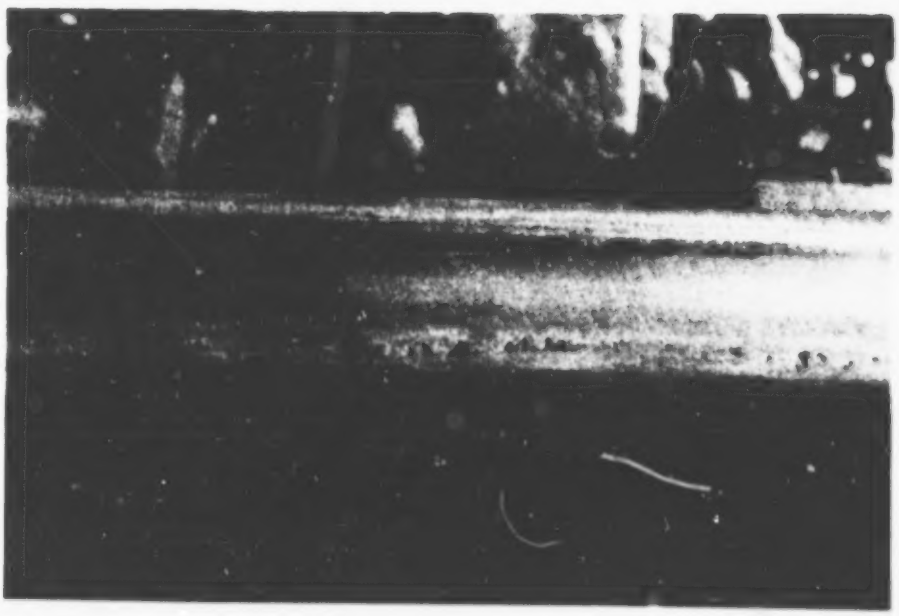


After three months, Curve No. 21, MP 27.0

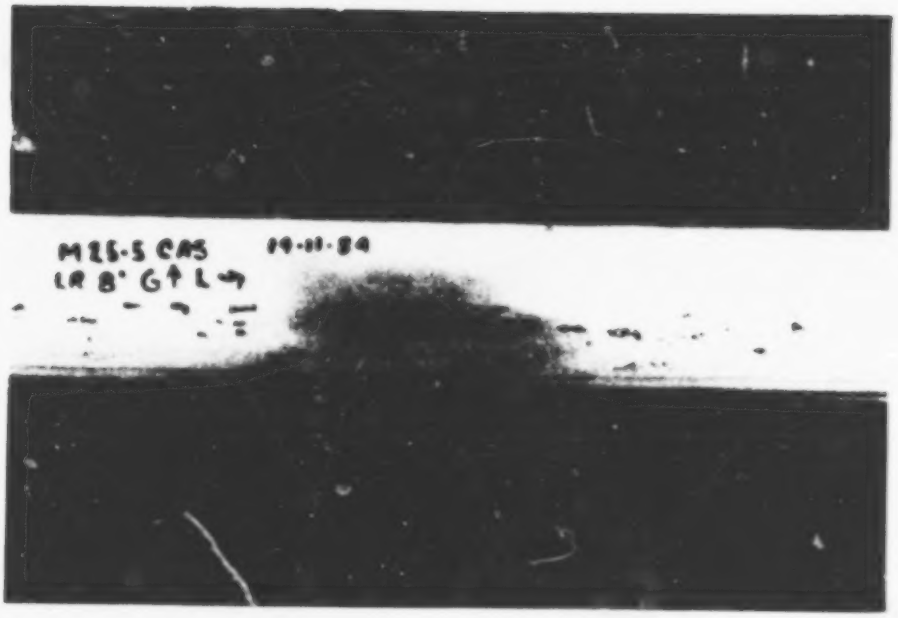


After three months, Curve No. 22, MP 27.3

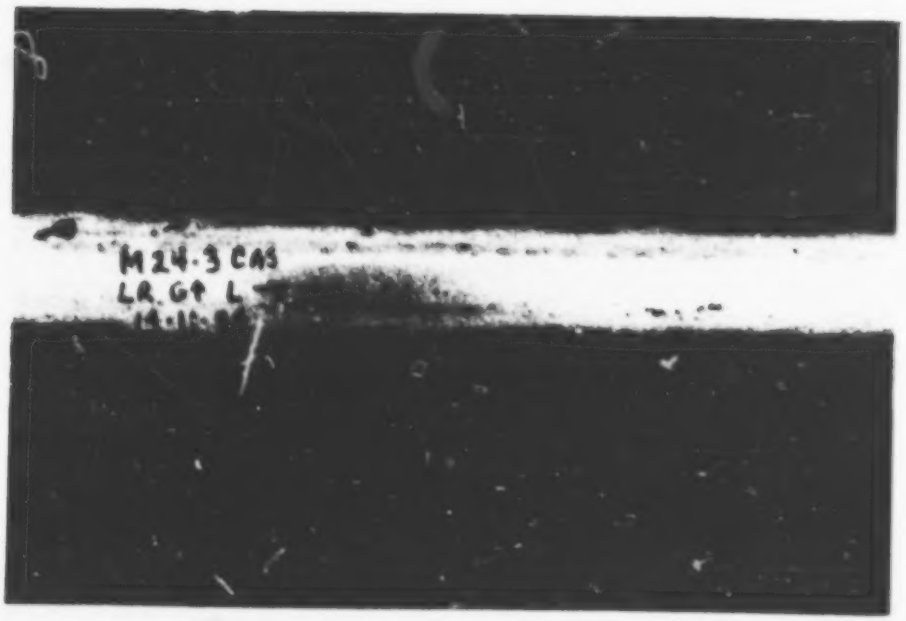




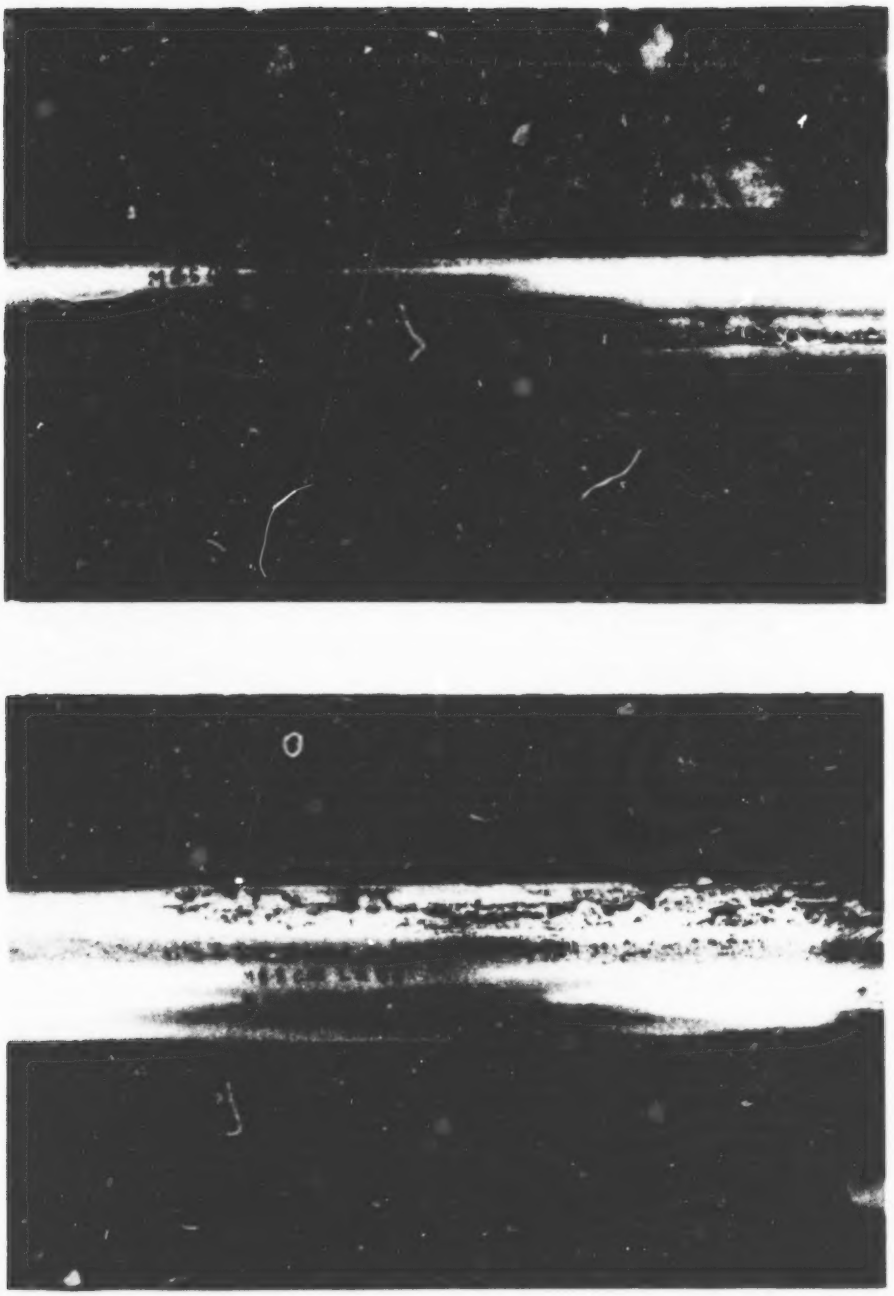
After six months, Curve No. 1, MP 26.0



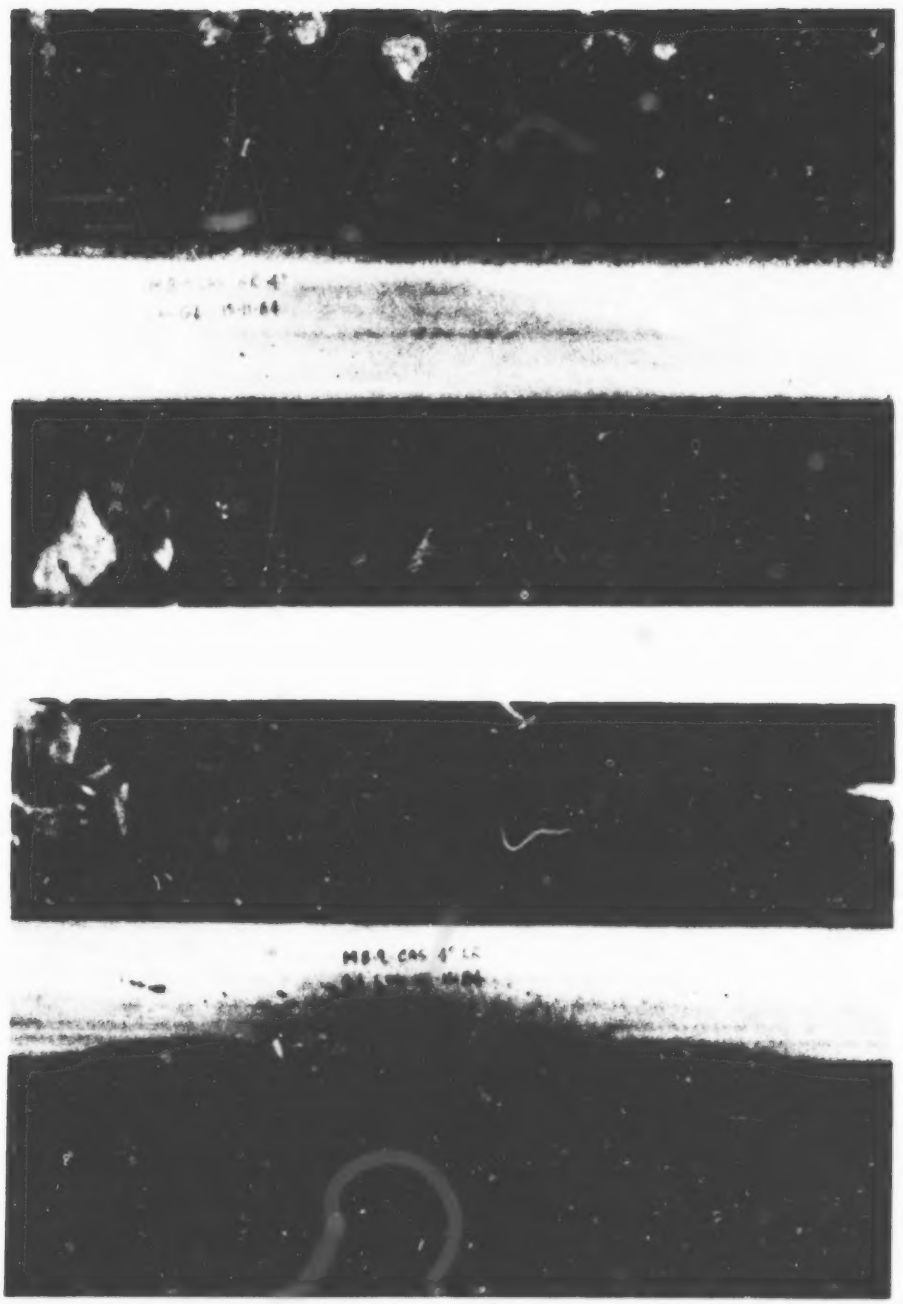
After six months, Curve No. 3, MP 25.5



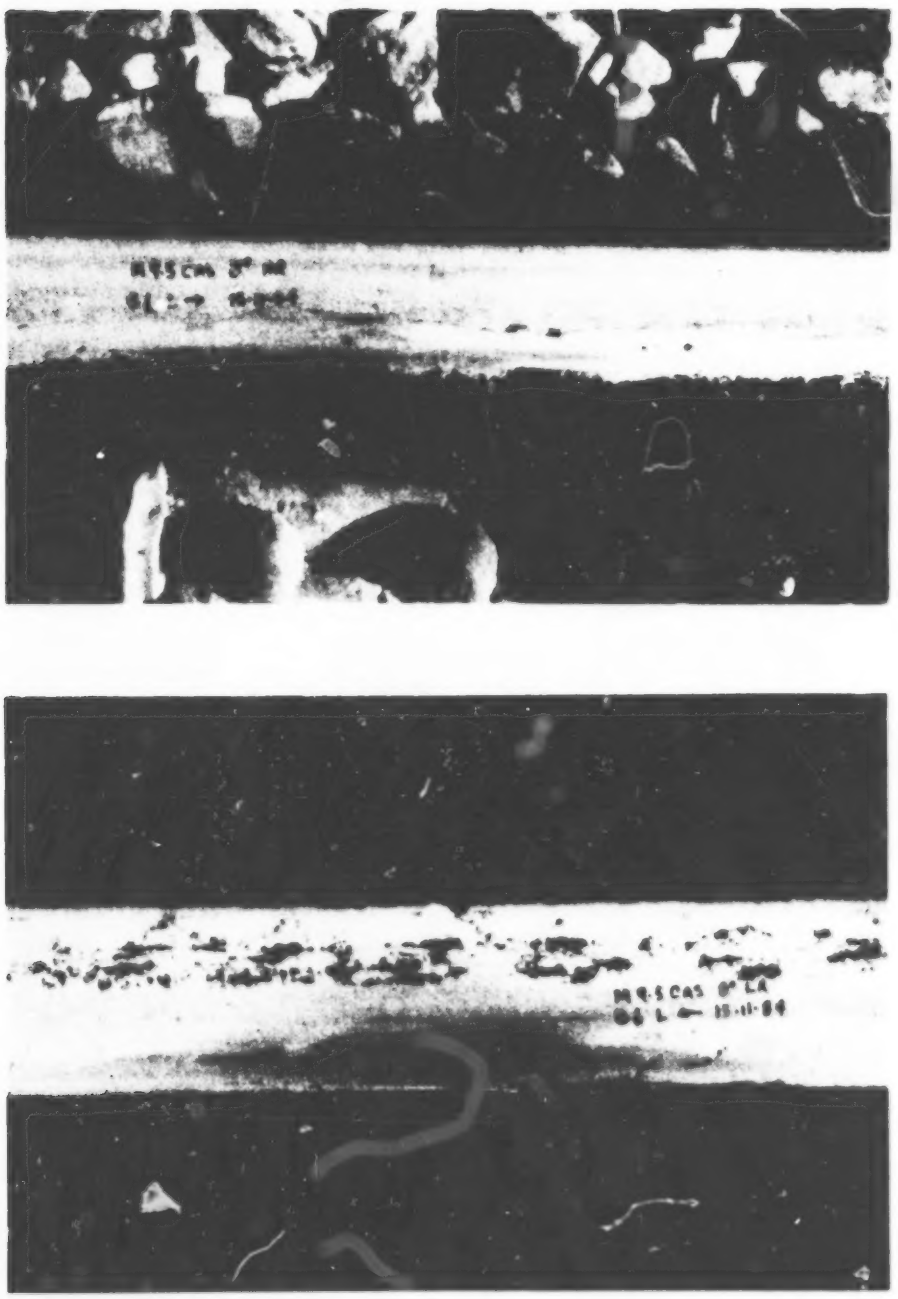
After six months, Curve No. 5, MP 24.3



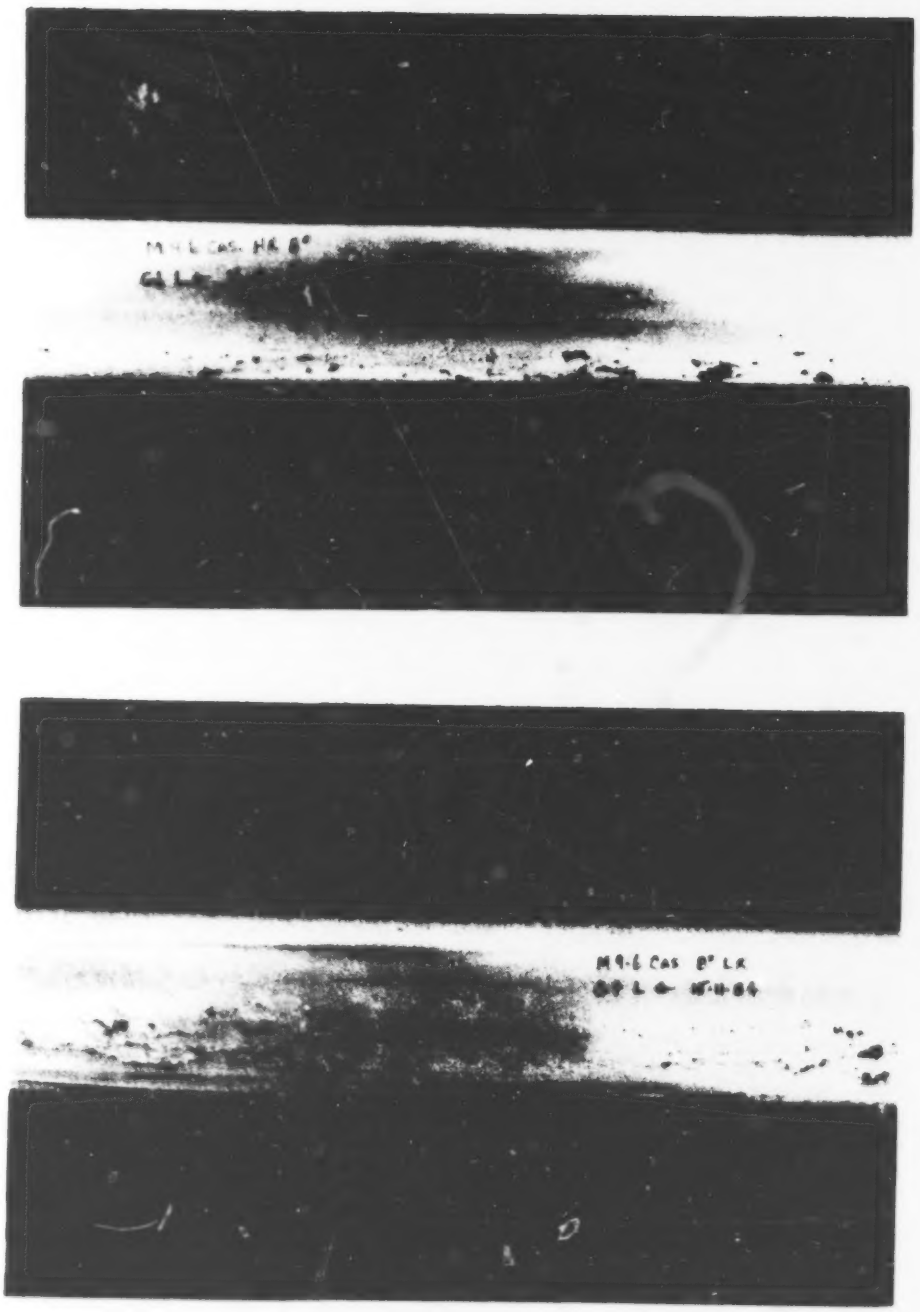
After six months, Curve No. 8, MP 8.5



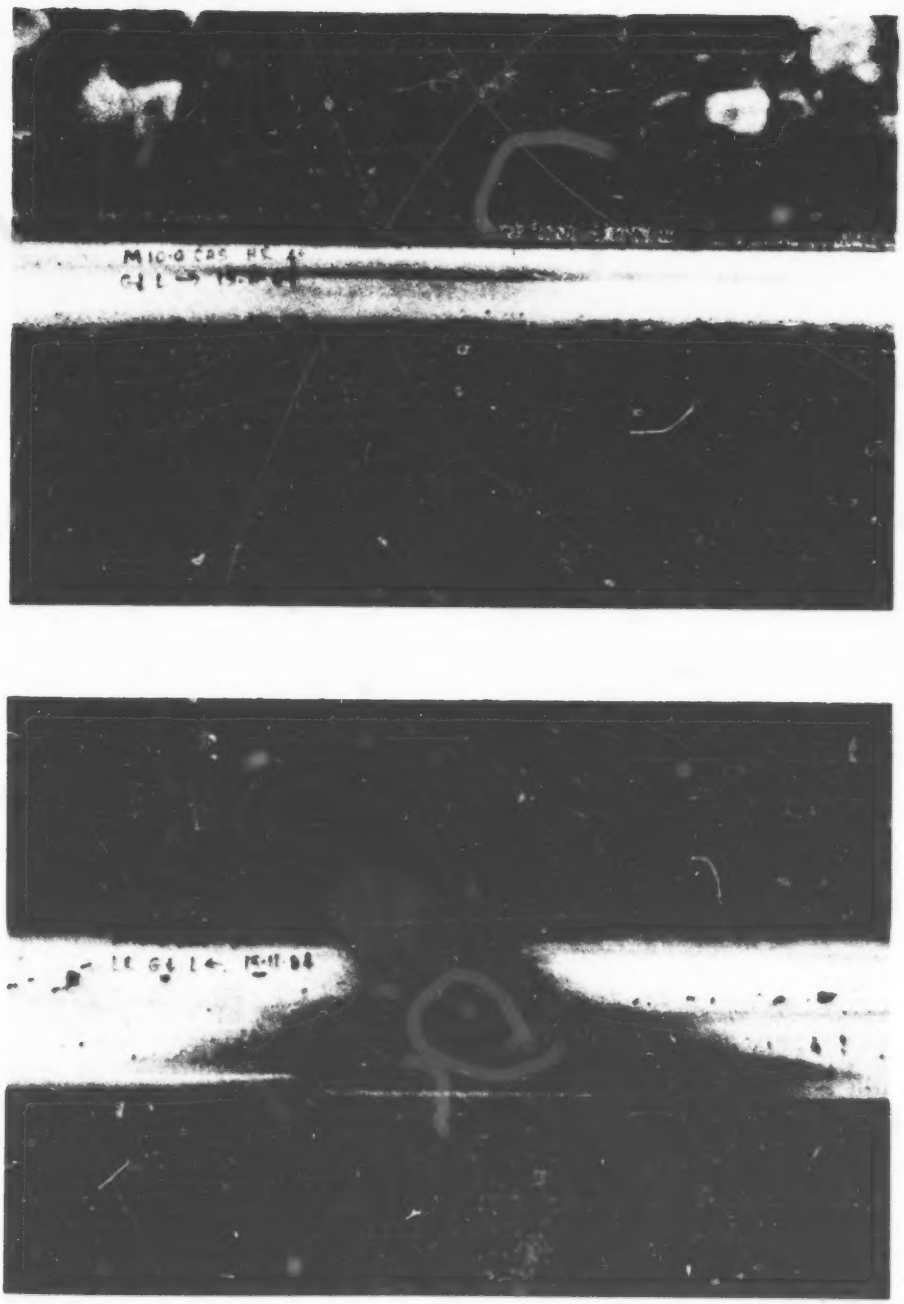
After six months, Curve No. 9, MP 8.9



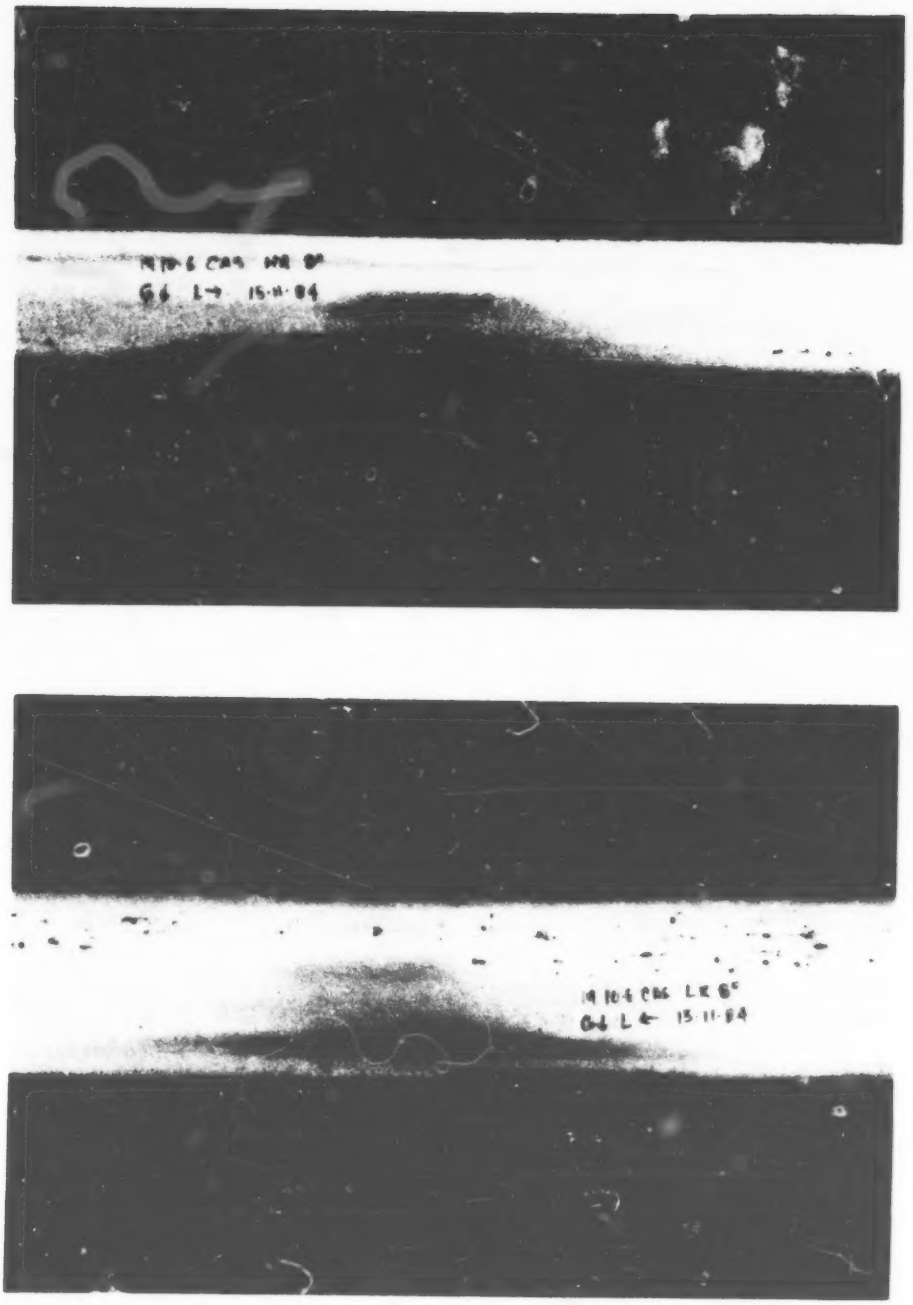
After six months, Curve No. 10, MP 9.5



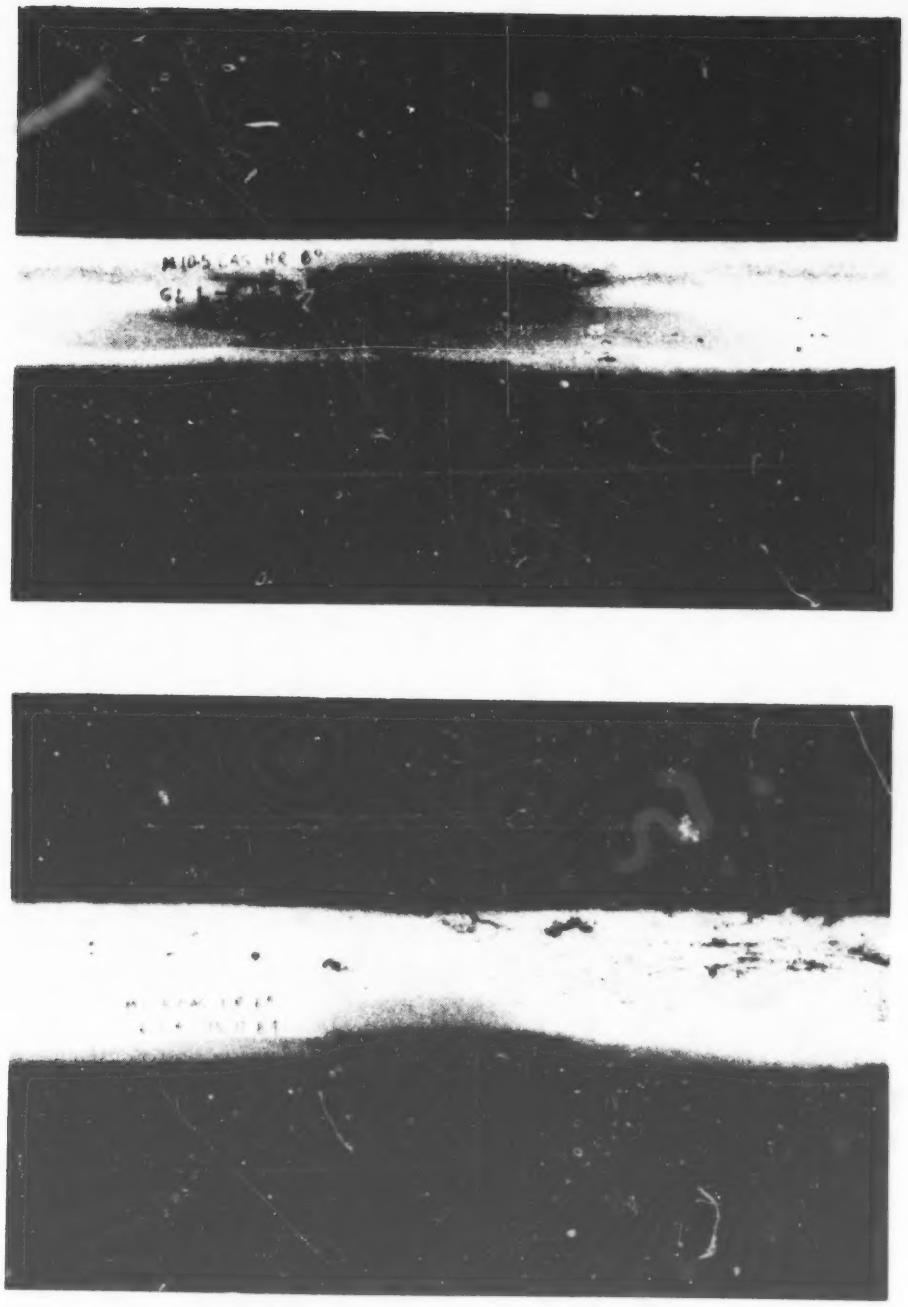
After six months, Curve No. 11, MP 9.6



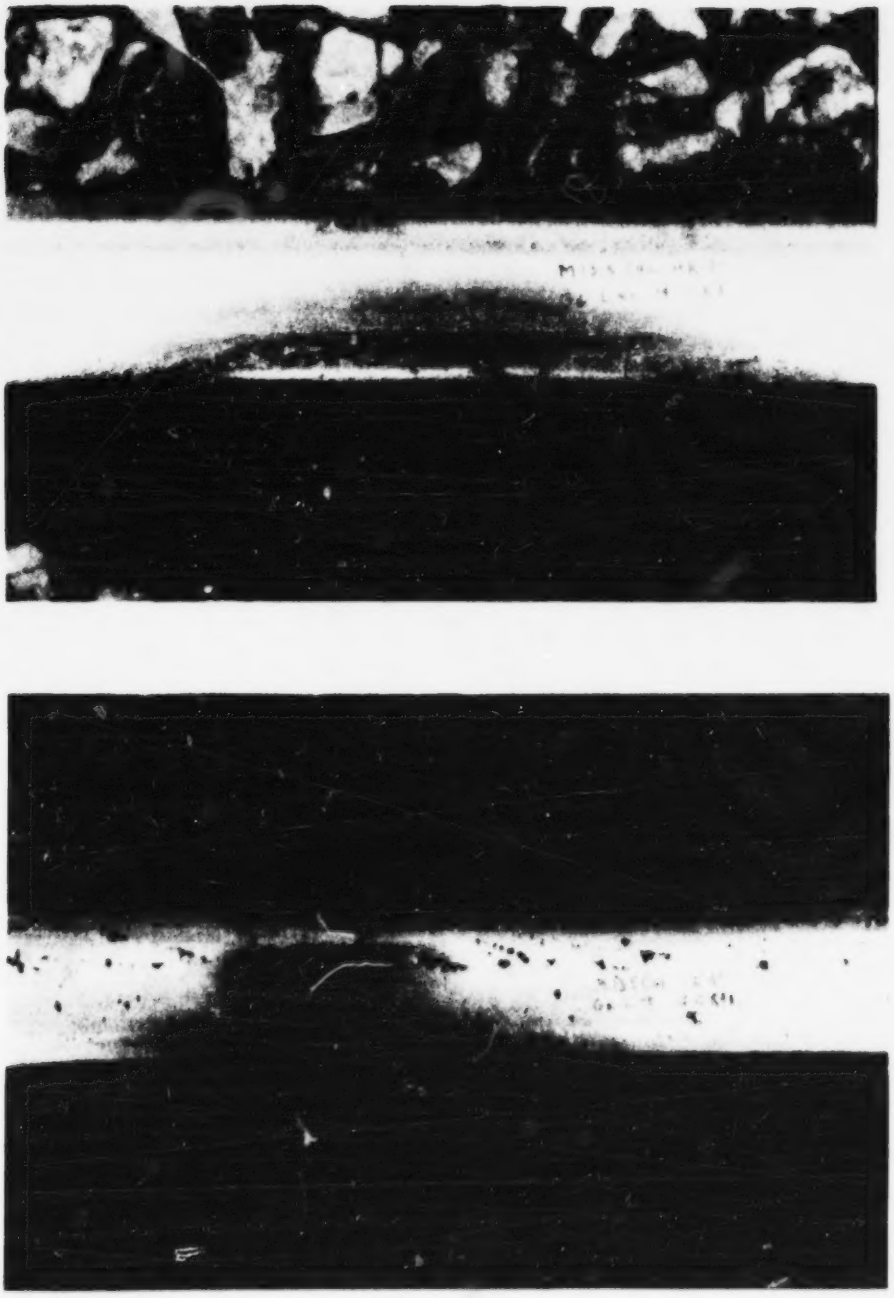
After six months, Curve No. 12, MP 10.0



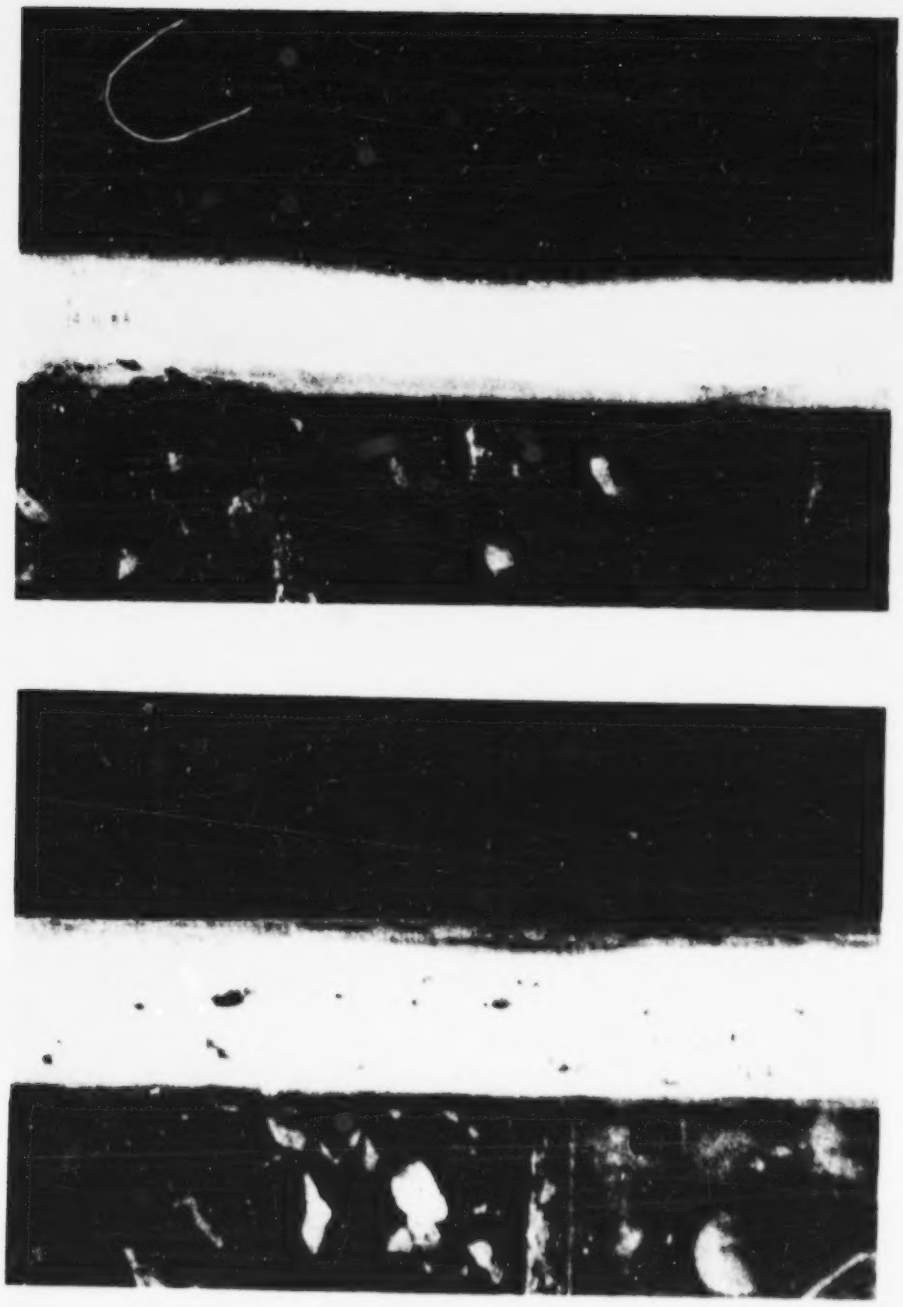
After six months, Curve No. 13, MP 10.6



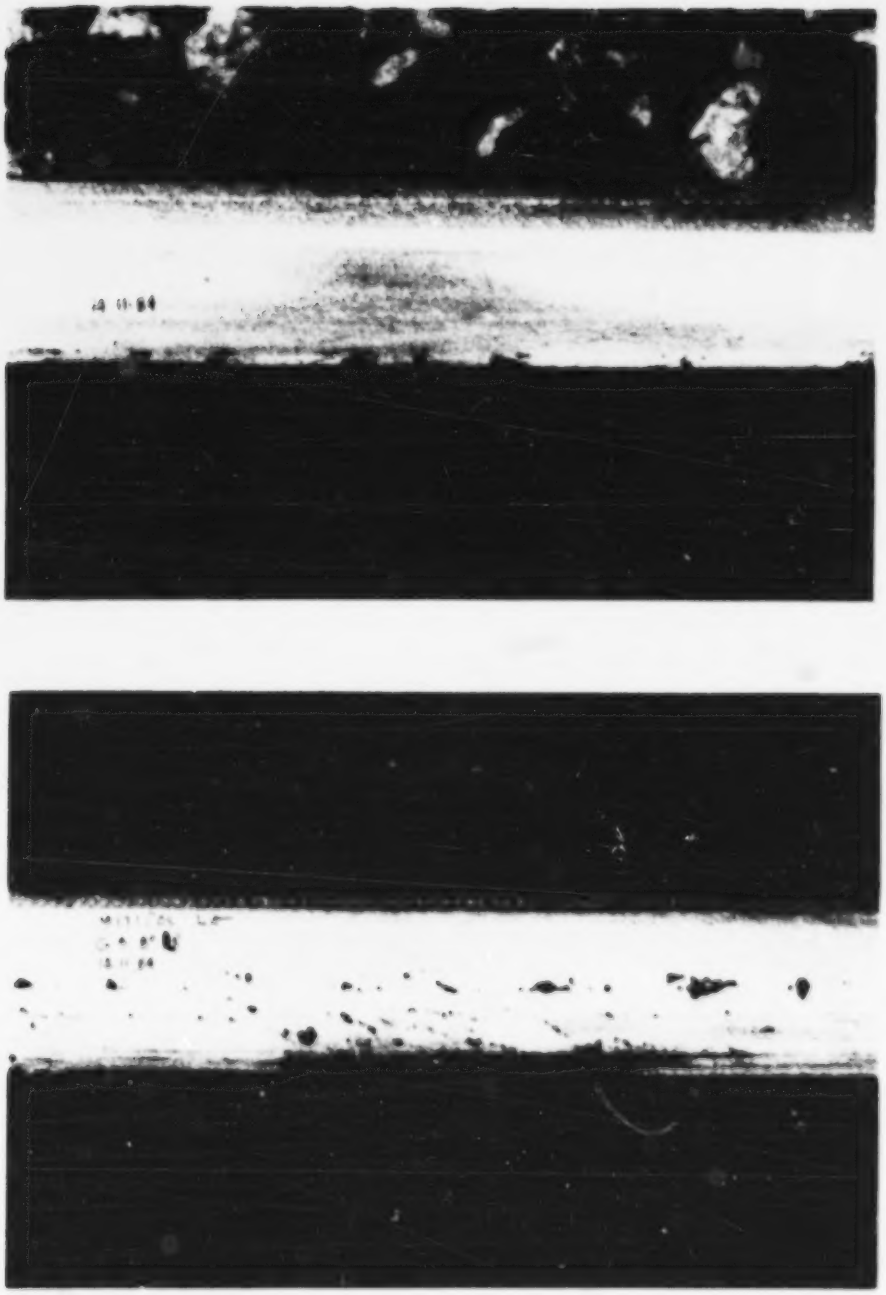
After six months, Curve No. 14, MP 10.5



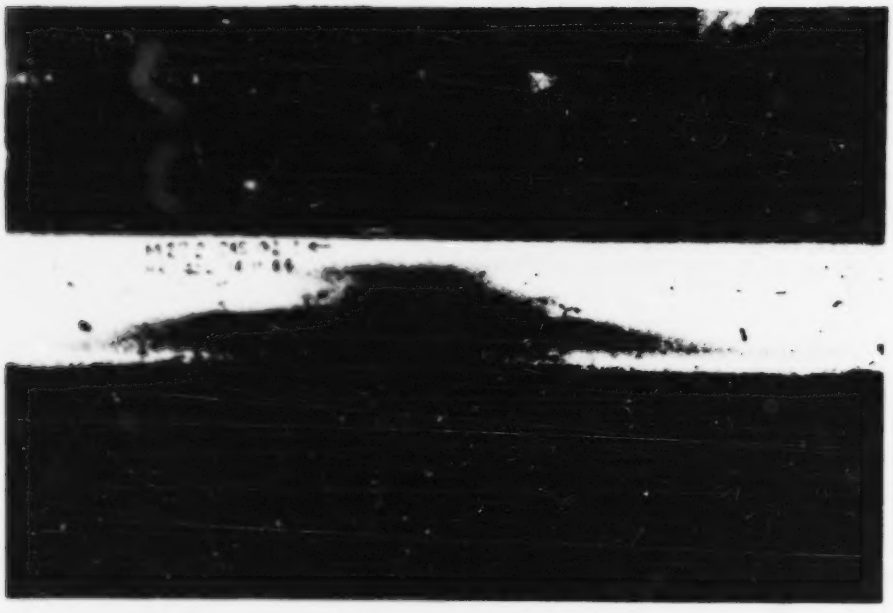
After six months, Curve No. 17, MP 13.5



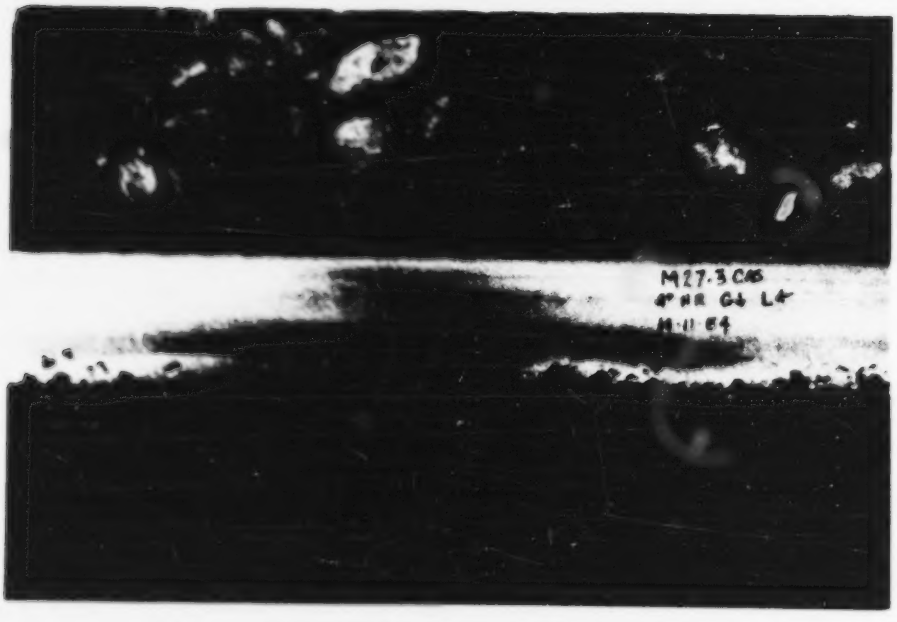
After six months, Curve No. 19, MP 17.0



After six months, Curve No. 20, MP 17.1



After six months, Curve No. 21, MP 27.0



After six months, Curve No. 22, MP 27.3

APPENDIX C

DETAILS OF RAIL PROFILE MEASUREMENTS IN THE TEST CURVES

RAIL PROFILE MEASUREMENTS FOR RAIL GRINDING TEST - PHASE II

Progress Summary No. 1

Planning and Research Department
CP Rail

August 30, 1984

Editorial note: This appendix contains an exact reproduction of CP Research progress summary report No. 1, "Rail Profile Measurements for Rail Grinding Test - Phase II," (August 30, 1984). The analyses and conclusions reported therein were made independently of CIGGT and do not necessarily reflect the views of this Institute or its researchers.

RAIL PROFILE MEASUREMENTS FOR RAIL GRINDING TEST - PHASE II

Progress Summary

1.0 Introduction

At the request of CP Rail's Engineering Department, Planning and Research carried out rail profile measurements in 12 preselected curves on the Cascade Subdivision. The rail profile measurements formed one element of an overall rail grinding optimization program to evaluate the effect of various grinding patterns on rail wear, shelling and corrugations.

Rail profile measurements were carried out three weeks prior to grinding, approximately one week after grinding of the test curves was completed and ten weeks after the initial grinding was completed.

2.0 Test Curves

The curves selected for the rail profile measurements were located on the Cascade Subdivision between Mileage 8 and 28, and consisted of six 8° and six 4° curves.

All test curves were measured for curvature, gauge and superelevation prior to selecting six locations in the fully developed section of each curve for profile measurements on the high and low rail. Each of the test locations in a curve were approximately 15 feet apart.

Measurements of gauge, curvature, superelevation, type of rail and when it was installed, general condition of the rail and the type of grinding carried out in each of the test curves are summarized in Table 1.

3.0 Rail Profile Measurements

Rail profile measurements in the test curves were carried out with Planning and Research's rail profilometer. Rail profiles measured prior to grinding, immediately after grinding and 10 weeks later were matched at the same location in each of the test curves so as to illustrate the grinding patterns and subsequent wear. A representative sample of matched profiles for all three sets of grinding measurements at two locations on the high and low rail, in each test curve are presented in Appendix 1. Rail profiles presented in Appendix 1 are grouped as to the type of grinding that was carried out.

The identification code used for the profile measurements is as follows:

ID: 00 000 0

- 00 — Test Site Number
- 000 — Reading Number (odd numbers on high rail, even numbers on low rail)
- 0 — Degree of Curve

e.g. ID: 031298 - Test Site 3, Reading Number 129 on High Rail, 8 Degree Curve.

4.0 Observations on Rail Grinding Profile Measurements Before and Immediately After Grinding

It was found that the ground rail profile was not identical for various locations within the same curve, even though all measurements were made in the fully developed section of the curve and were within 100 feet. This variation in the ground rail profile was found irregardless of whether the original rail contours were similar (eg. ID 111474 and ID 111454 on page 34) or dissimilar (ID 031298 and 031238 on page 33).

Listed below are comments on the various grinding methods used in the study.

CPR-H Grinding Pattern For High Rail In 8° and 4° Curves

- Grinding not always uniform across the rail head.

- An example of the ground rail profile which illustrates the variation that exists in the same 8° curve can be seen by comparing ground rail profiles ID 031238 and ID 031298 on pages 8 and 9.

CN-H Grinding Pattern For High Rail In 8° and 4° Curves

- Grinding concentrated more to the field side of the rail head with a heavy taper on the field side. There is little or no grinding from the centre of rail head to the gauge corner as can be seen from rail profiles ID 051018 and ID 051058 on pages 17 and 18.

CIG-STD Grinding Pattern For High Rail In 8° and 4° Curves

- Grinding concentrated more from the centre of rail head to the field side of rail head, with a slight grinding of the gauge corner.

CIG-C Grinding Pattern For Low Rail In 8° and 4° Curves

- Grinding concentrated more from the centre of the rail head to the field side.

- An example of the ground rail profile which illustrates the variation that could exist on the same 8° curve can be observed by comparing ground rail profiles ID 030248 and ID 030308 on pages 8 and 9.

CN-L Grinding Pattern For Low Rail In 8° and 4° Curves

- Grinding concentrated near the field and gauge side of the rail head (heavy taper) with very little grinding about the centre of the rail head.

5.0 Observations on Rail Grinding Profile Measurements Ten Weeks After Grinding (Approximately 11 million gross tons)

No wear data is reported as the matched profiles showed there was very little wear that occurred after ten weeks irrespective of grinding pattern.

The gauge corners of the high rail in the 4° and 8° curves that were ground to the CIG-STD, CN-H and CPR-H grinding patterns had all returned to their original worn contour. A combination of flange wear and plastic flow of metal to the gauge corner restored the rail to its original contour. In some cases when the gauge corner was not ground it simply continued to wear parallel to the original worn contour.

The field side of the high rail in the 4° and 8° curves that were ground by the CIG-STD, CN-H and CPR-H grinding methods retained their grinding pattern.

The heavy taper on the field side of the low rail due to grinding with the CN-L profile was retained in most cases for the 4° and 8° curves. In some cases, there was evidence of metal flow towards the field side. On the gauge side of the low rail, if the grinding taper was heavy, the taper was retained.

For the CIG-C grinding profile in the 4° and 8° curves when there was a light taper on the field side of the low rail, the rail contour returned to the original worn contour. On the gauge side of the low rail where there was little or no grinding, the rail returned to or wore parallel to the original worn contour.

TEST SITES FOR RAIL GRINDING OPTIMIZATION PROGRAM

Code For Type of Grinding High Rail	Code For Type of Grinding Low Rail	Test Site No	Mileage Location On Cascade Subdivision	Curvature (Degrees)	Measured Curvature (Degrees)	Over Gauge (Inches)	Super-elevation (Inches)	Type of Rail (High Rail)	Type of Rail (Low Rail)	Condition of Rail (High Rail)	Condition of Rail (Low Rail)	Remarks
CN-H	CIG-C	1	8.5	8°R	7.5°-8°	1/4"-1/2"	4"	Algoma CC 136 lb RE 1980 July (Installed 1980)	Algoma CC 136 lb RE 1980 July (Installed 1980)	Some surface shells	Some surface shells Corrugations	High rail well lubricated. Note: High rail transposed to low rail location & used rail installed in high rail location after initial measurements but before grinding
CN-H	CN-L	2	8.9	4°L	4° 5°	1/2"	13/4"	Algoma CC 136 lb RE 1979 Feb (Installed 1980)	Algoma CC 136 lb RE 1980 March (Installed 1980)	Surface shelling from center of rail head to field side of rail. Corrugations over short distance	Some surface shells Corrugations	High rail well lubricated. Note: High rail replaced after initial measurements but before grinding. Low rail as before
CPR-H	CIG-C	3	9.6	8°R	8.5°-9°	1/4"-3/8"	3 1/2"	Algoma CC 136 lb RE 1980 May (Installed 1980)	Algoma CC 136 lb RE 1980 April (Installed 1980)	Some surface shells	Excessive surface shells Corrugations	Rail transposed. Low rail in bad condition. Very little grease on high rail gauge corner
CN-H	CIG-C	4	10	4°R	3.5°-4°	1/8"	2 1/2"	Algoma CC 136 lb RE 1980 June (Installed 1981)	Algoma CC 136 lb RE 1980 June (Installed 1981)	Rail in good condition	Corrugations	High rail well lubricated. High rail in good condition with very little gauge face wear
CN-H	CN-L	5	10.5	8°R	7.5°	0-1/4"	3 1/2"-3 3/4"	Algoma CC 136 lb RE 1980 June (Installed 1981)	Algoma CC 136 lb RE 1980 June (Installed 1981)	Some surface shells	Some surface shells Light corrugations	High rail well lubricated
CIG-STD	CIG-C	6	10.6	8°R	8°	1/4"	3 3/4"	Algoma CC 136 lb RE 1980 June (Installed 1981)	Algoma CC 136 lb RE 1980 June (Installed 1981)	Some shelling of high rail gauge corner	Some surface shells Light corrugations	High rail well lubricated. Rail transposed
CPR-H	CN-L	7	13.5	4°L	4.3°	0-1/8"	2 1/2"	Algoma CC 136 lb RE 1981 Nov (Installed June 1982)	Algoma CC 136 lb RE 1981 Nov (Installed June 1982)	Good condition	Some surface shells more towards field side Light corrugations	High rail well lubricated
CPR-H	CN-L	8	17	8°L	8°-8.2°	1/4"	3 1/4"-3 3/4"	Algoma CC 136 lb RE 1982 April (Installed June 1982)	Algoma CC 136 lb RE 1982 April (Installed June 1982)	Good condition	Surface shells from center of rail head to field side Light corrugations	High rail well lubricated
CIG-STD	CIG-C	9	17.1	8°L	8.5°	1/4"-3/8"	3 3/4"	Algoma CC 136 lb RE 1982 April (Installed June 1982)	Algoma CC 136 lb RE 1982 April (Installed June 1982)	Good condition	Some surface shells from rail head centre to field side Light corrugations	High rail well lubricated
CIG-STD	CIG-C	10	26	4°R	4.25°	1/4"	3"-3 1/4"	Algoma CC 136 lb RE 1980 Feb (Installed June 1982)	Algoma CC 136 lb RE 1980 Nov (Installed June 1982)	Cracks on gauge corner. Very little wear	Some surface shells on field side. Very light corrugations	High rail well lubricated
CIG-STD	CIG-STD	11	27	4°L	4°-4.25°	0	3 1/2"-4"	Algoma CC 136 lb RE 1982 March (Installed June 1982)	Algoma CC 136 lb RE 1980 Nov (Installed June 1982)	Cracks on gauge corner. Very little wear	Some shelling towards field side of rail head	
CPR-H	CN-L	12	27.3	4°L	4°-4.25°	0	2 3/4"	Algoma CC 136 lb RE 1982 April (Installed June 1982)	Algoma CC 136 lb RE 1982 Feb (Installed June 1982)	Cracks on high rail gauge corner	Good condition	High rail well lubricated
		13	9.5	8°L	8.25°-8.5°	3/8"-1/2"	3 1/2"	Algoma CC 136 lb RE 1980 April (Installed 1980)	Algoma CC 136 lb RE 1980 April (Installed 1980)	Some shelling on high rail gauge corner	Surface shells on rail head centre to field side	Rail transposed. High rail well lubricated

CODE FOR TYPE OF RAIL GRINDING

- CIG-STD = CIGGT - recommended pattern for high rail and new non-corrugated low rail
- CIG-C = CIGGT - recommended pattern for corrugated low rail
- CPR-H = CP Research - recommended pattern for high rail
- CN-H = CN - pattern for high rail
- CN-L = CN - pattern for low rail (with and without corrugation)

TABLE 1

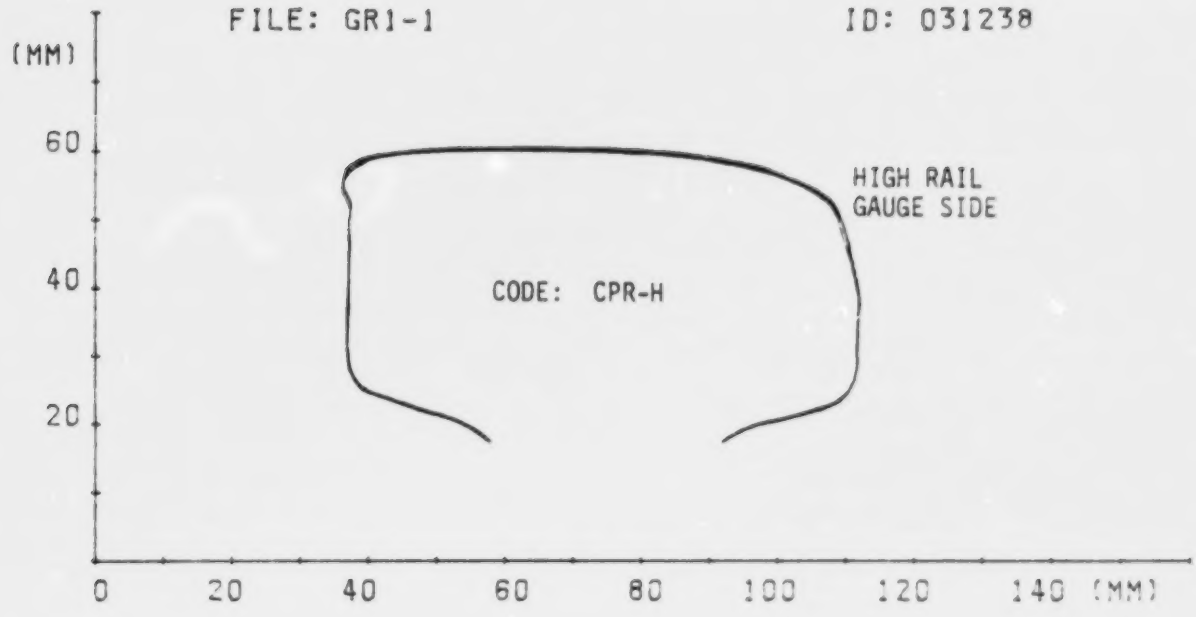
Appendix 1

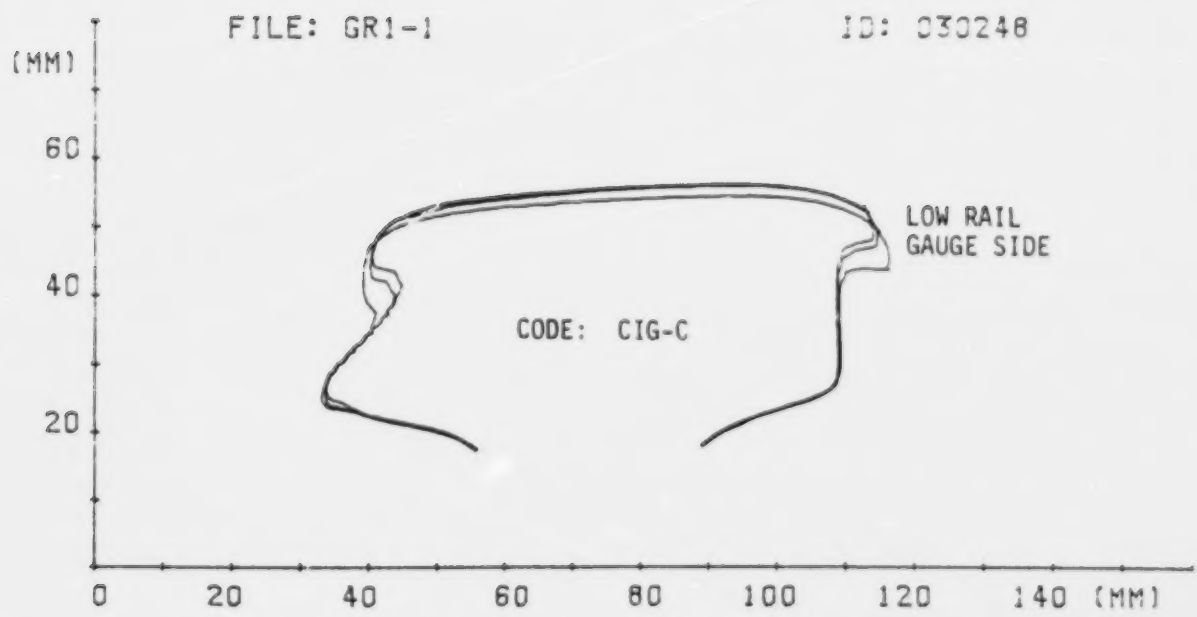
Matched Rail Pofiles Before Grinding, Immediately
After Grinding and Approximately Ten Weeks After Grinding

CPR-H - Grinding for High Rail in 8° and 4° Curves

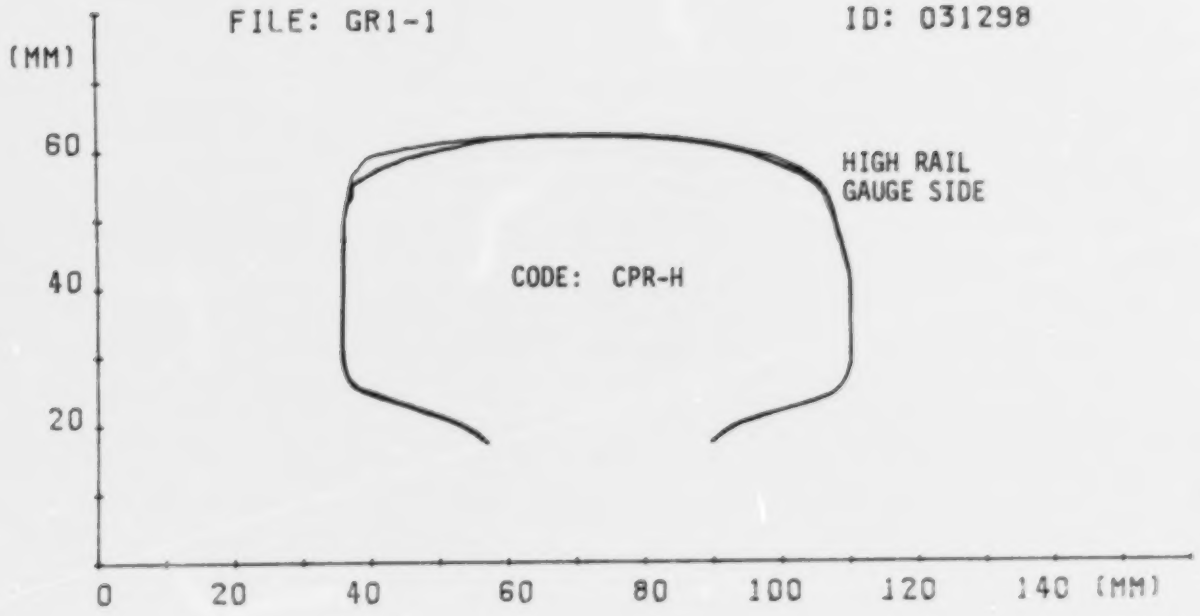
CN-L - Grinding for Low Rail in 8° and 4° Curves

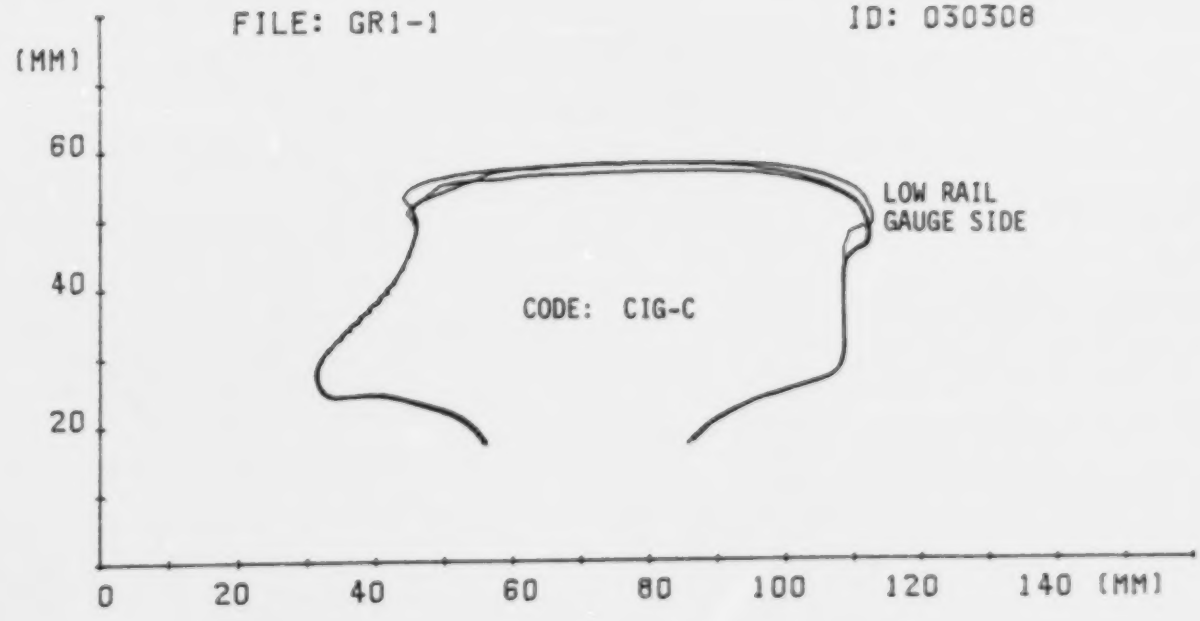
CIG-C - Grinding for Low Rail in 8° and 4° Curves





TEST SITE 3, 8 DEGREE CURVE, MILEAGE 9.5





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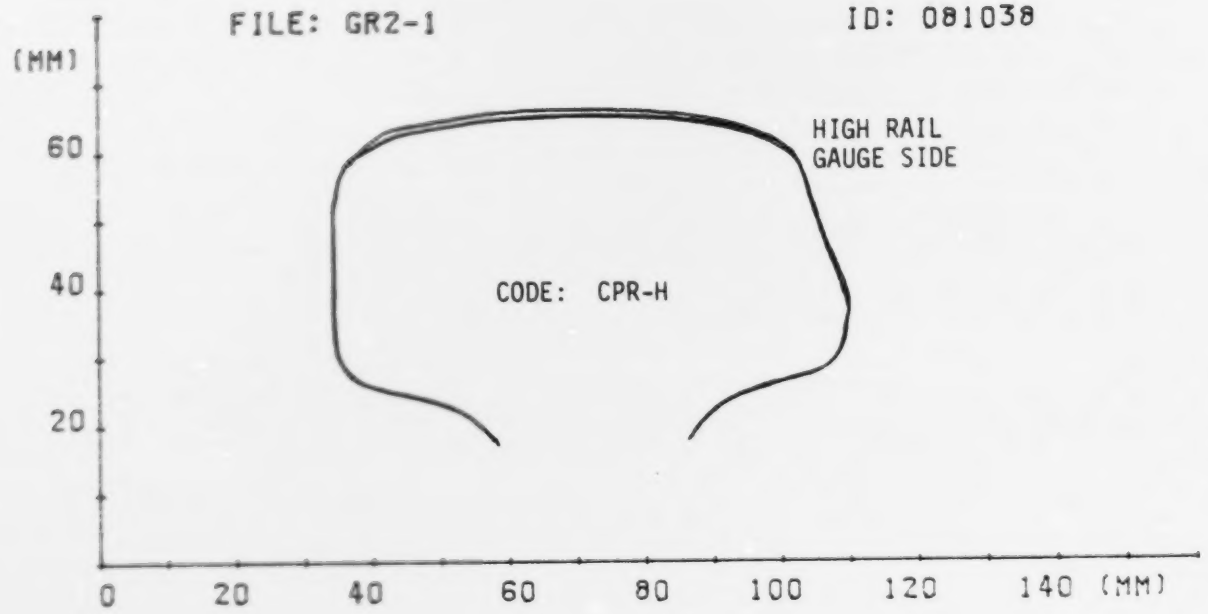
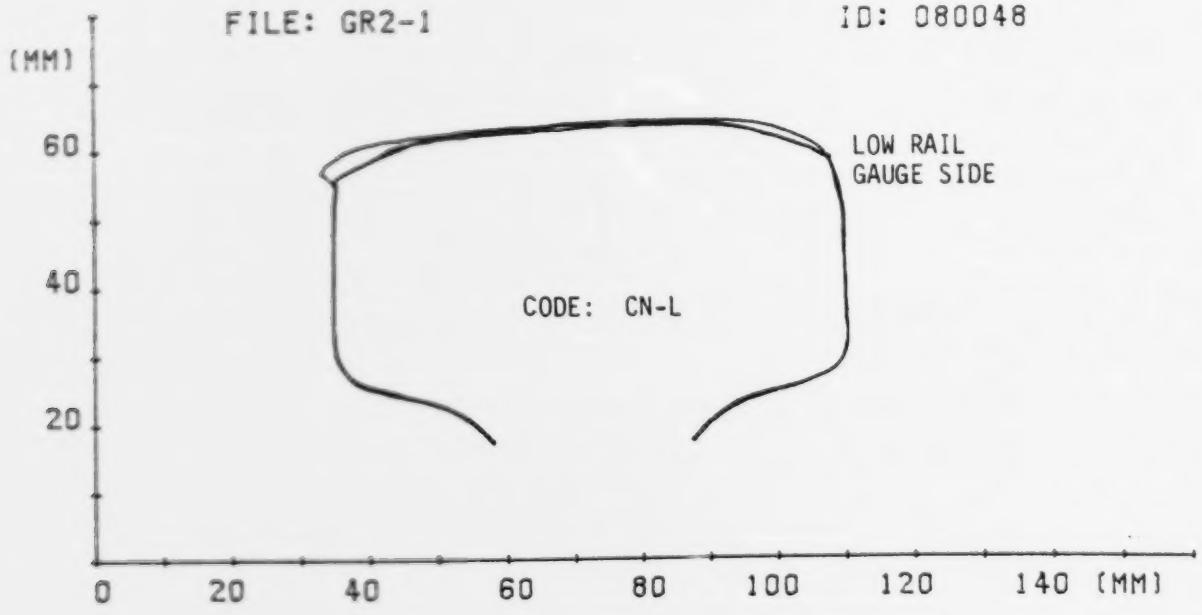
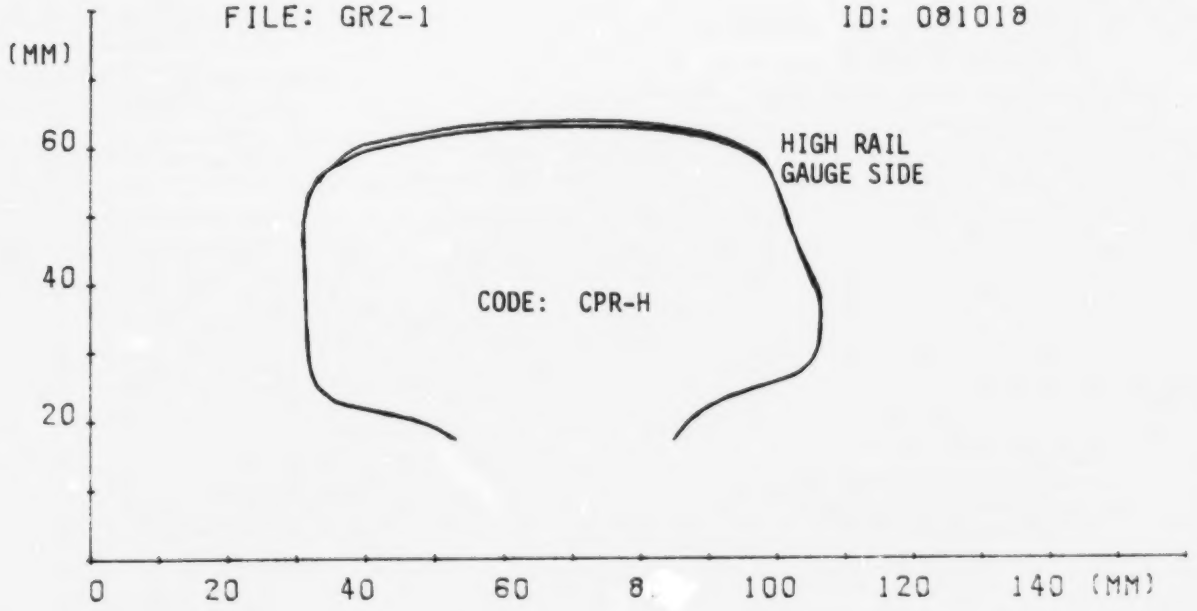
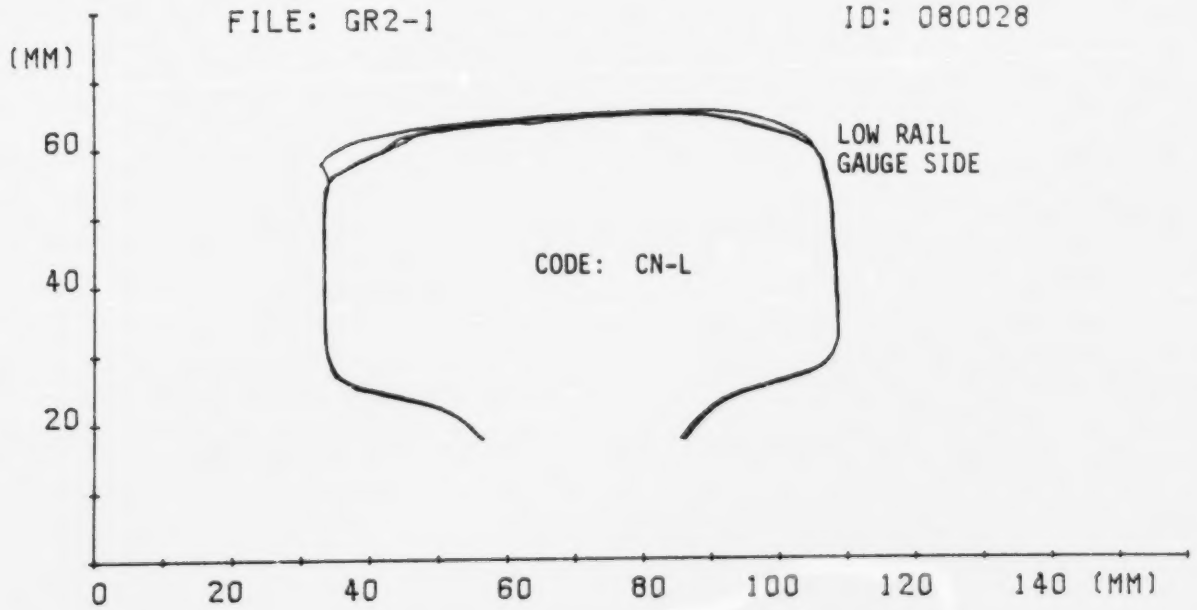




TEST SITE 8, 8 DEGREE CURVE AT MILEAGE 17





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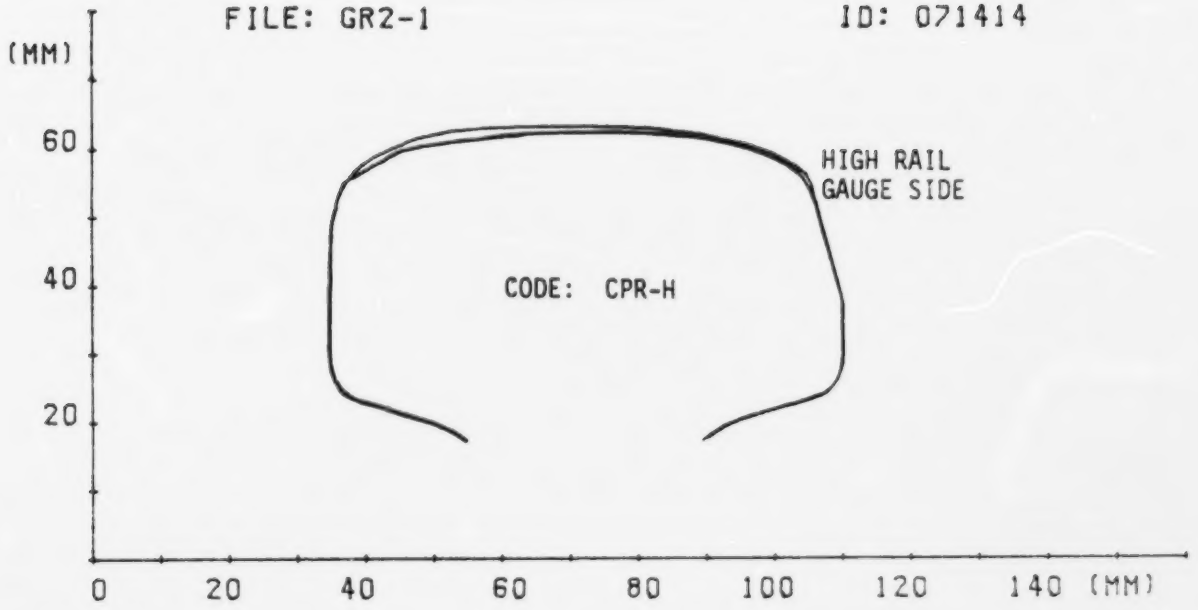
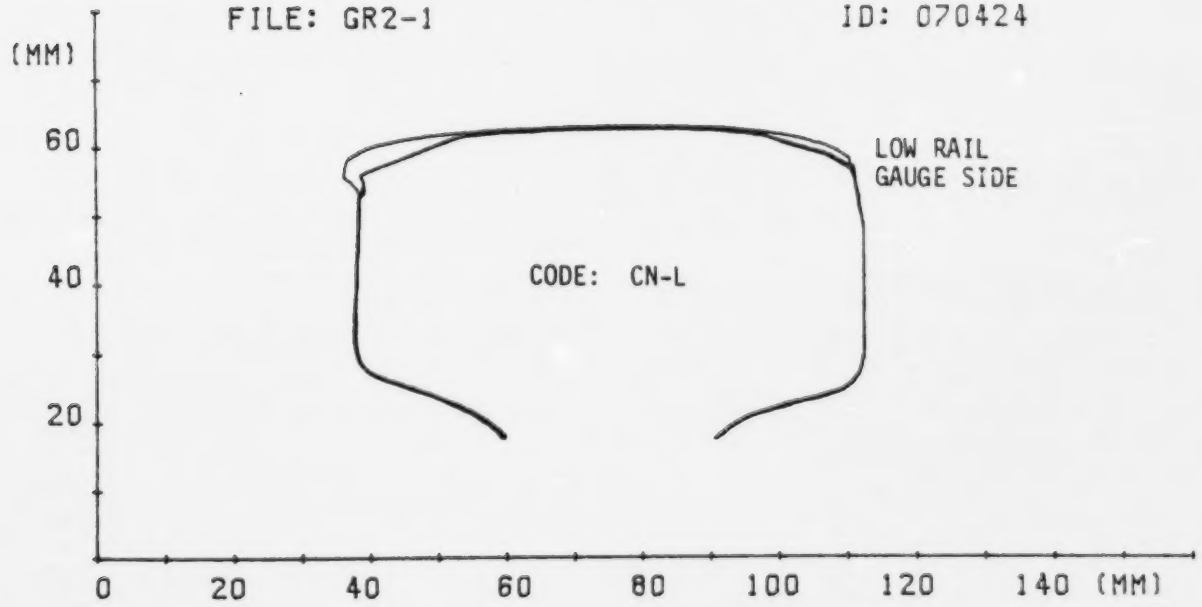
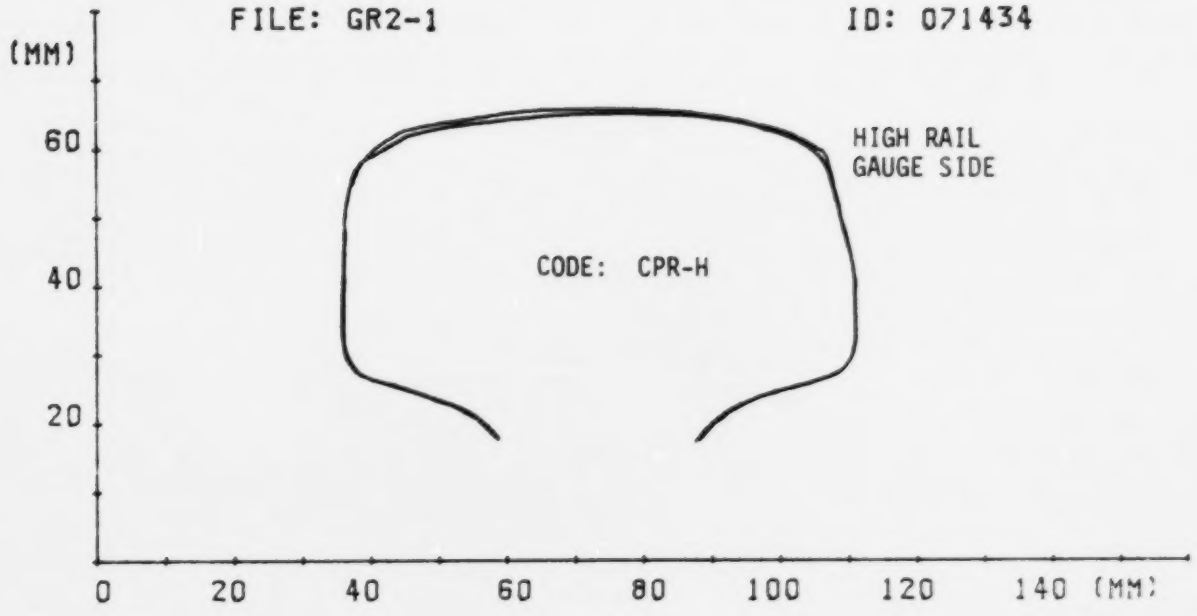
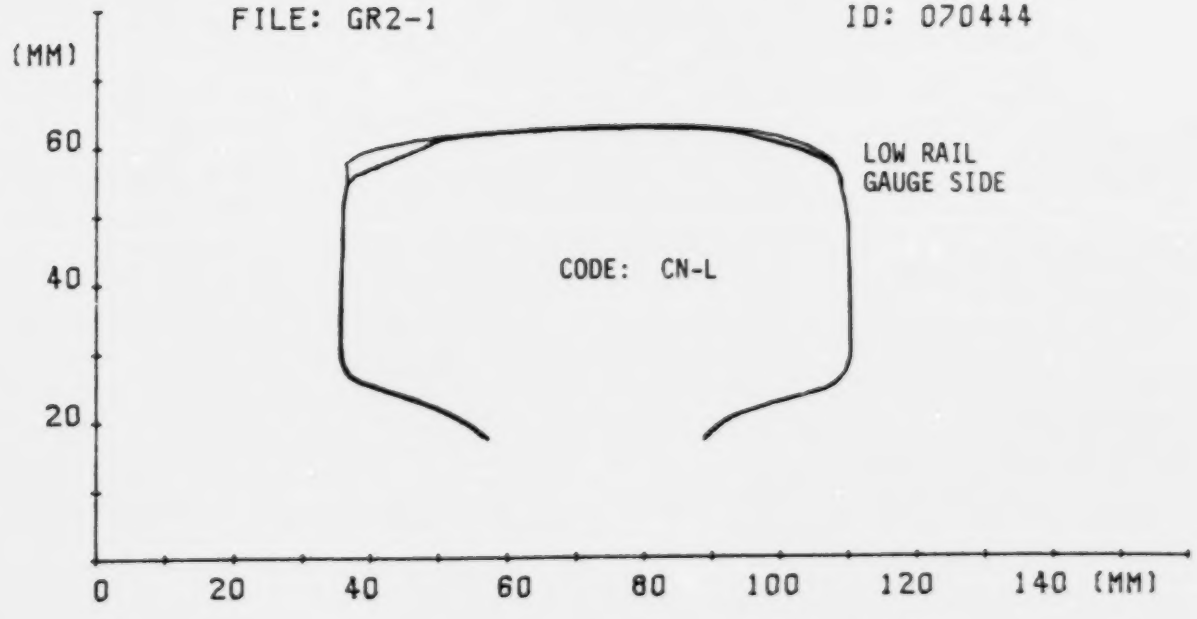


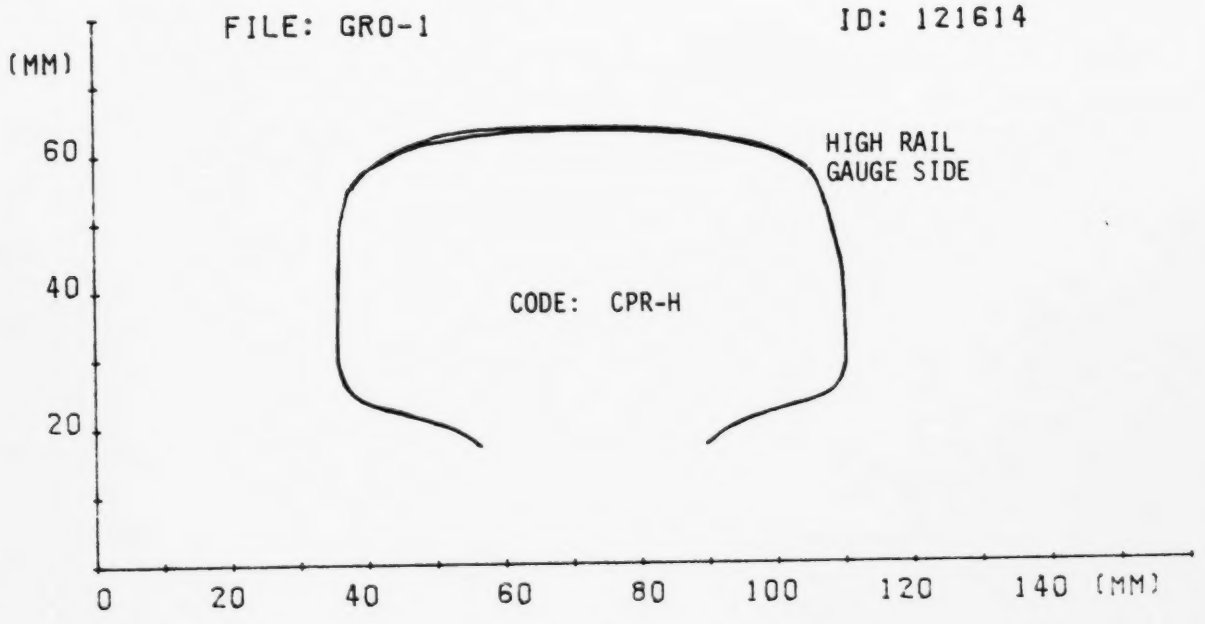


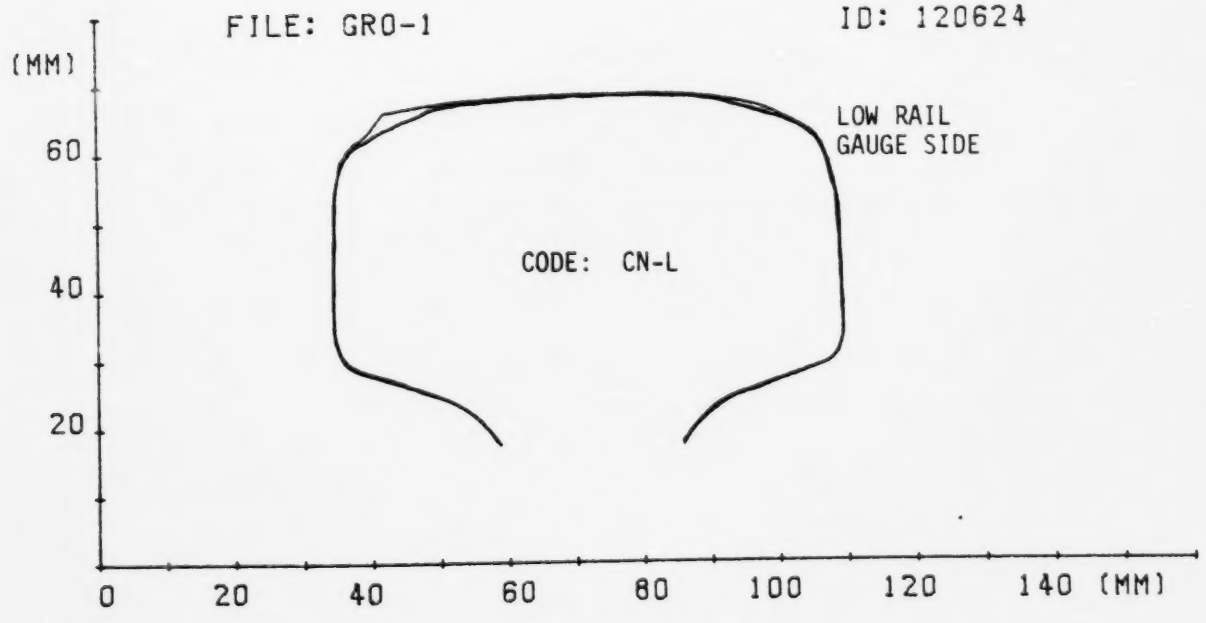
TEST SITE 7, 4 DEGREE CURVE, AT MILEAGE 13.4



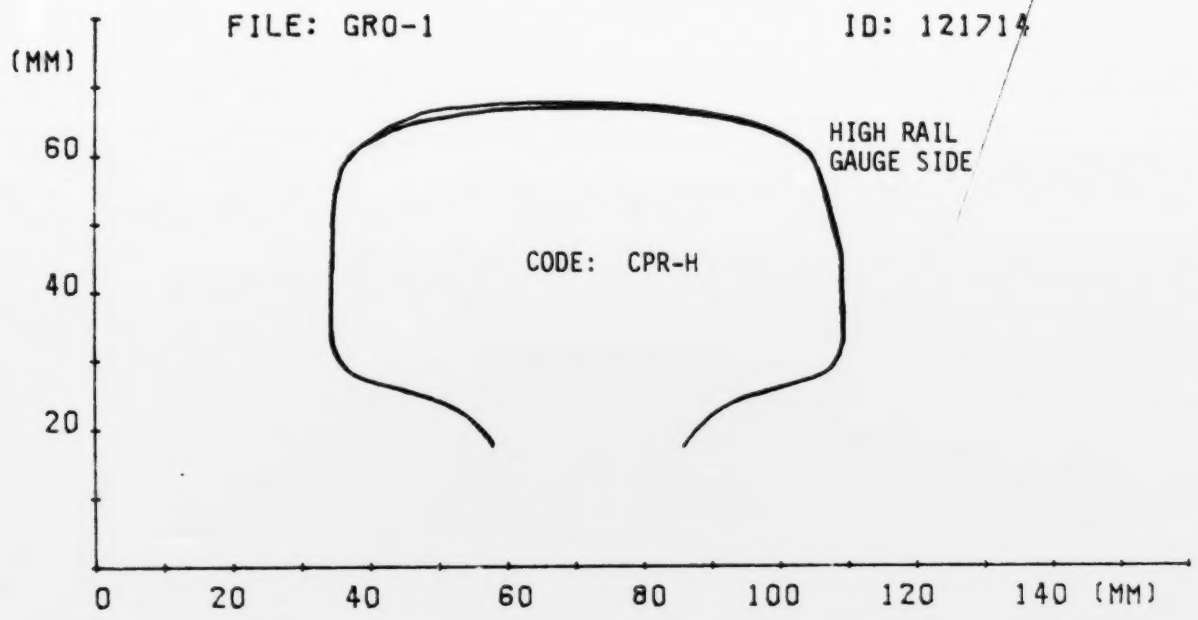


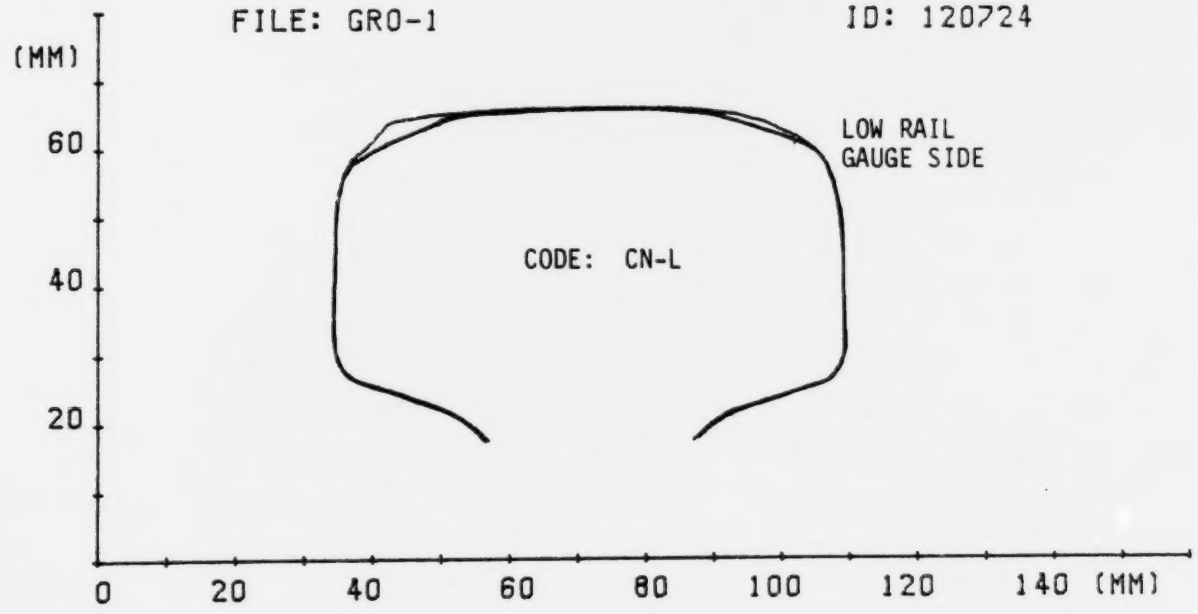
TEST SITE 7, 4 DEGREE CURVE AT MILEAGE 13.4





TEST SITE 12, 4 DEGREE CURVE AT MILEAGE 27.4

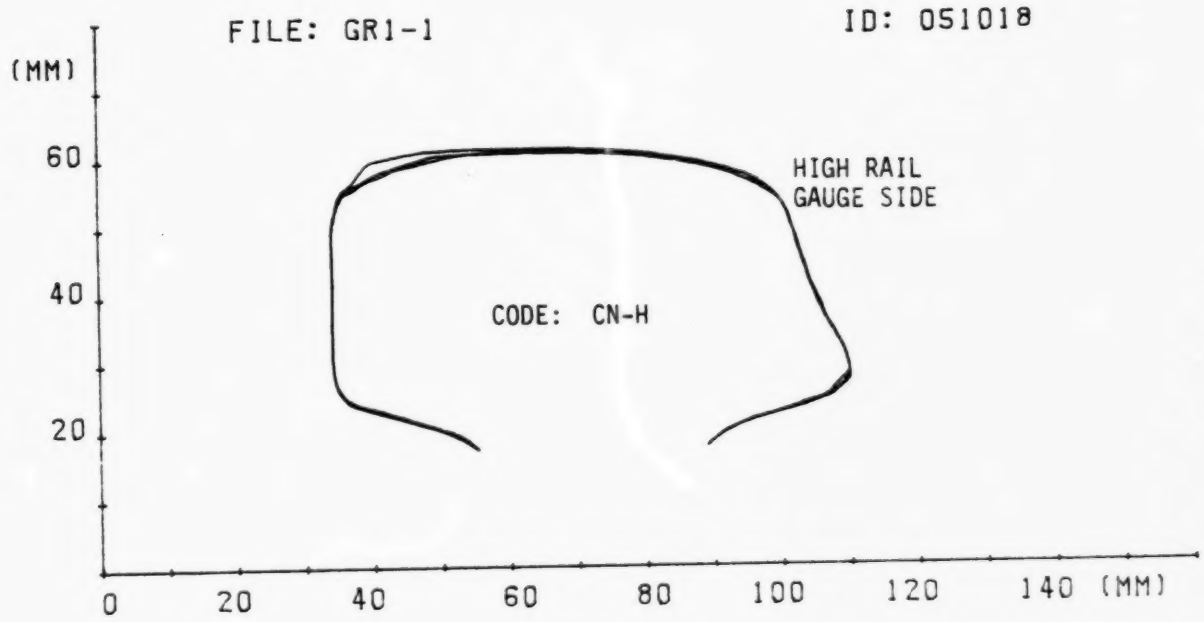


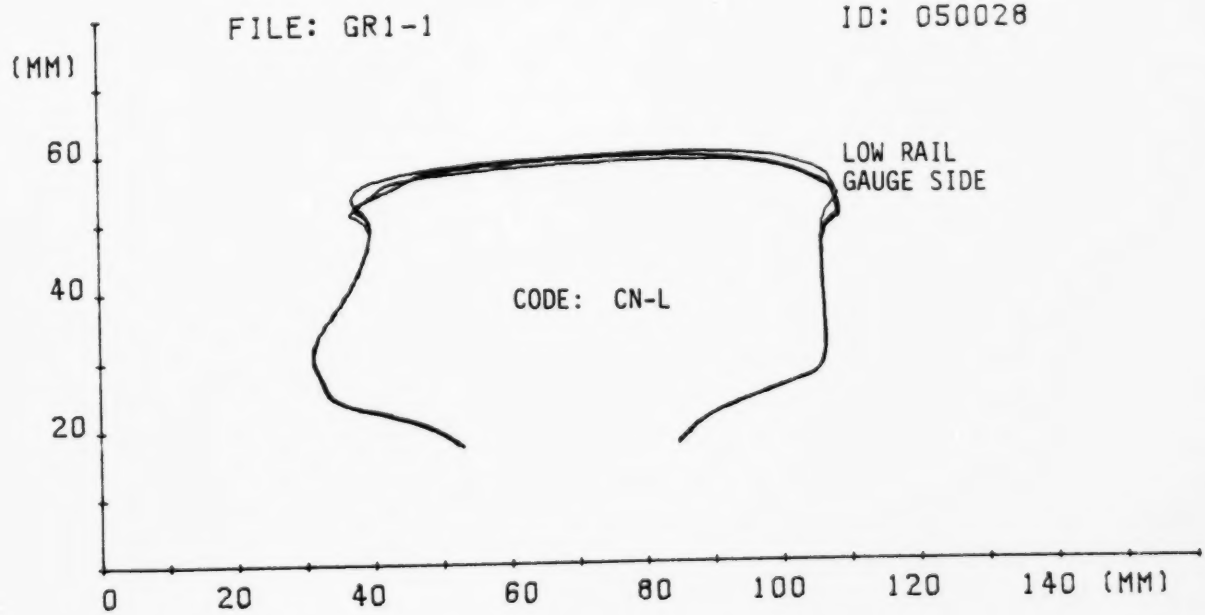


TEST SITE 12, 4 DEGREE CURVE AT MILEAGE 27.4

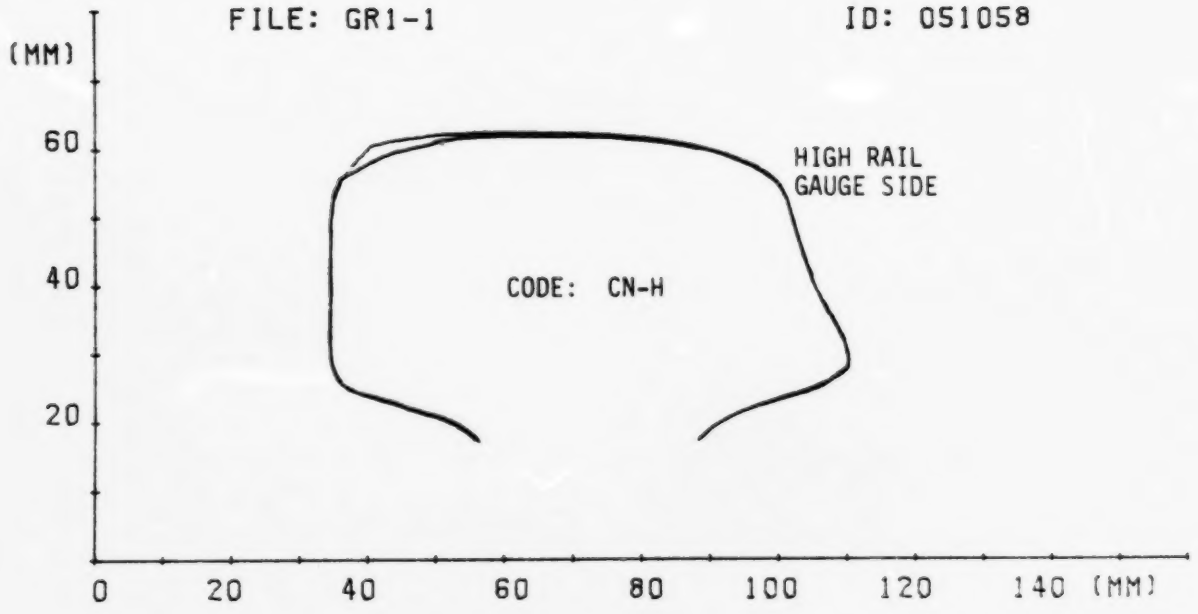
CN-H - Grinding for High Rail in 8° and 4° Curves

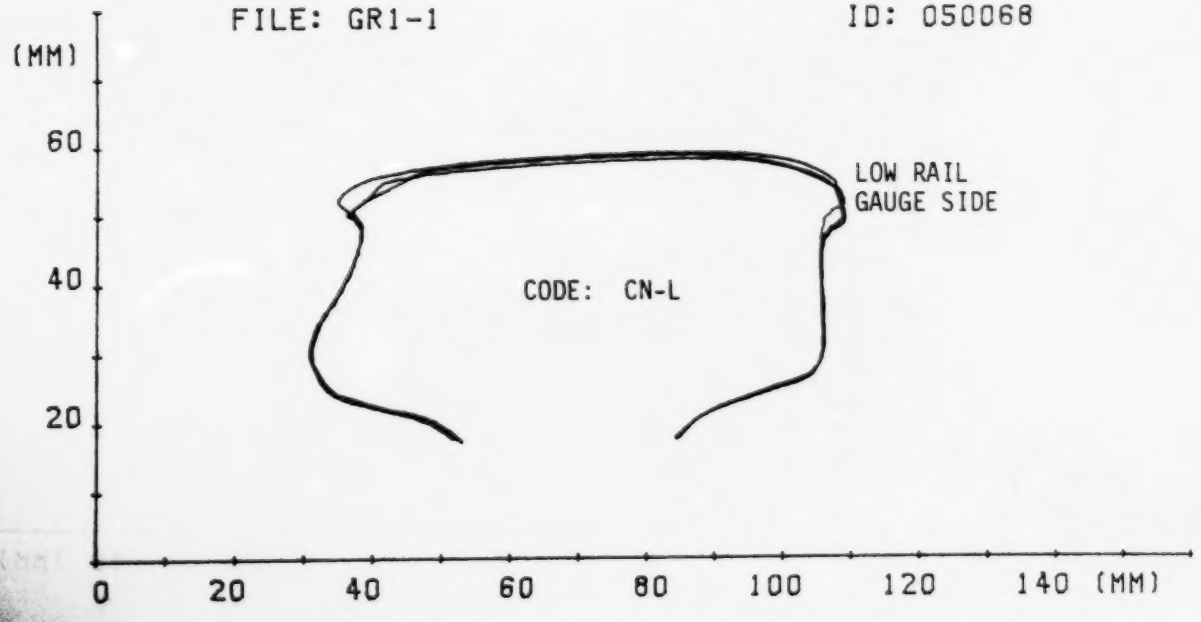
CN-L - Grinding for Low Rail in 8° and 4° Curves





TEST SITE 5, 8 DEGREE CURVE AT MILEAGE 10.5





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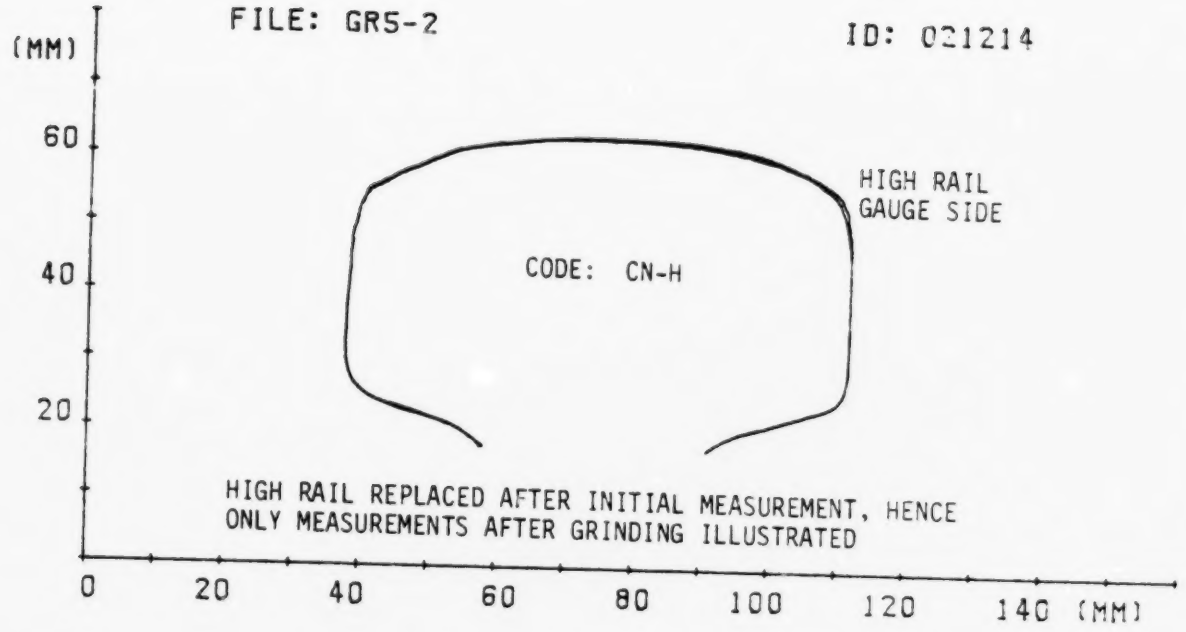
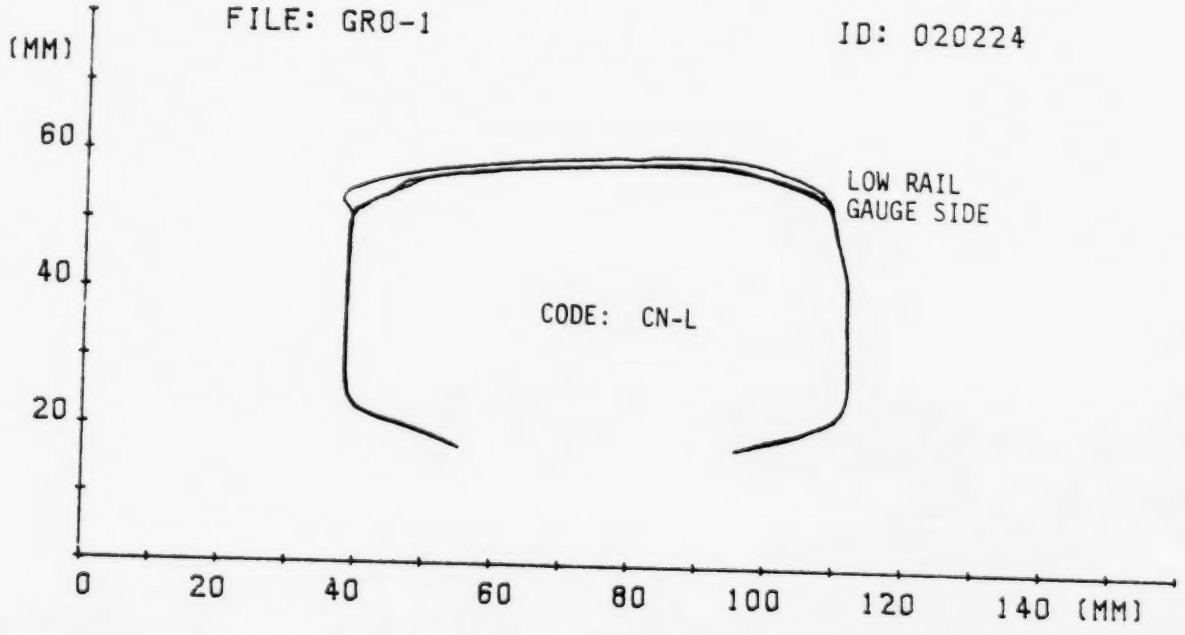
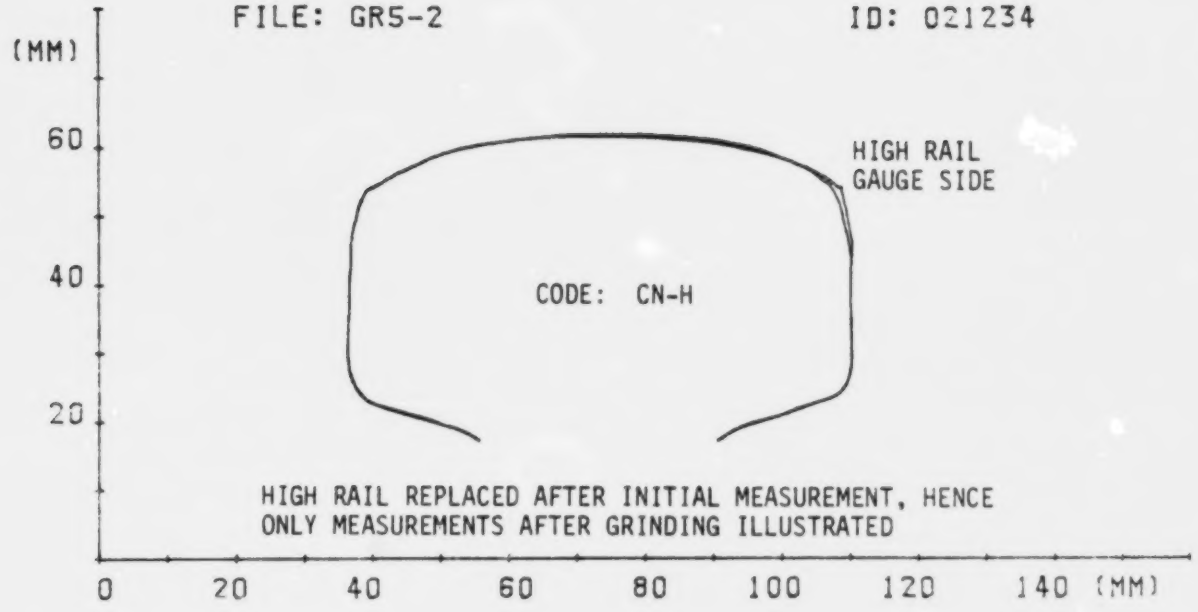
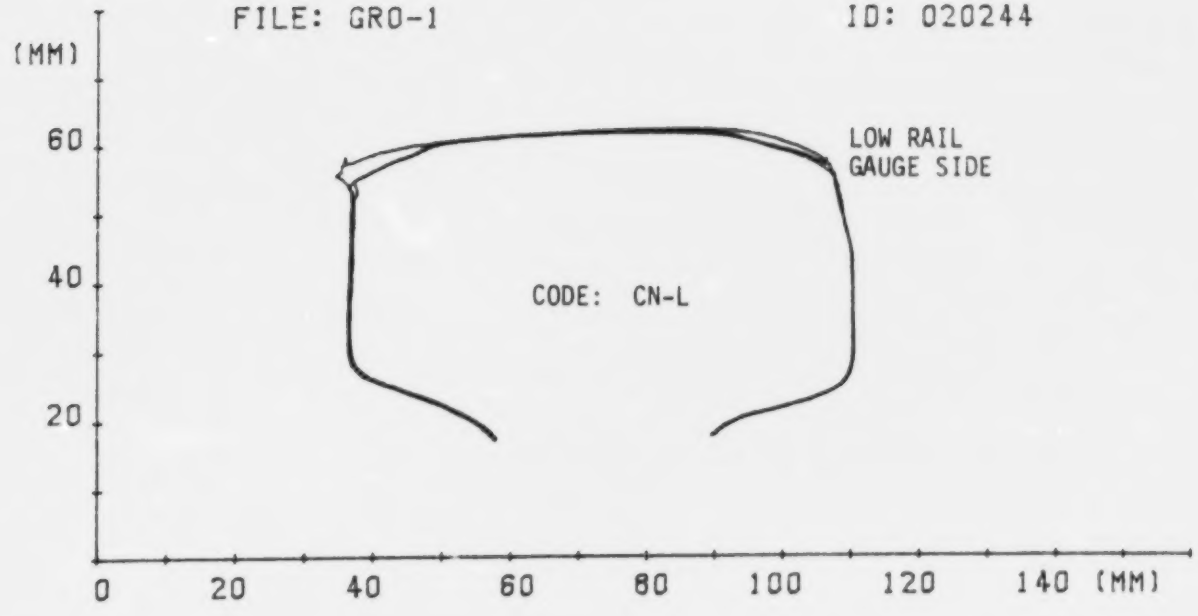


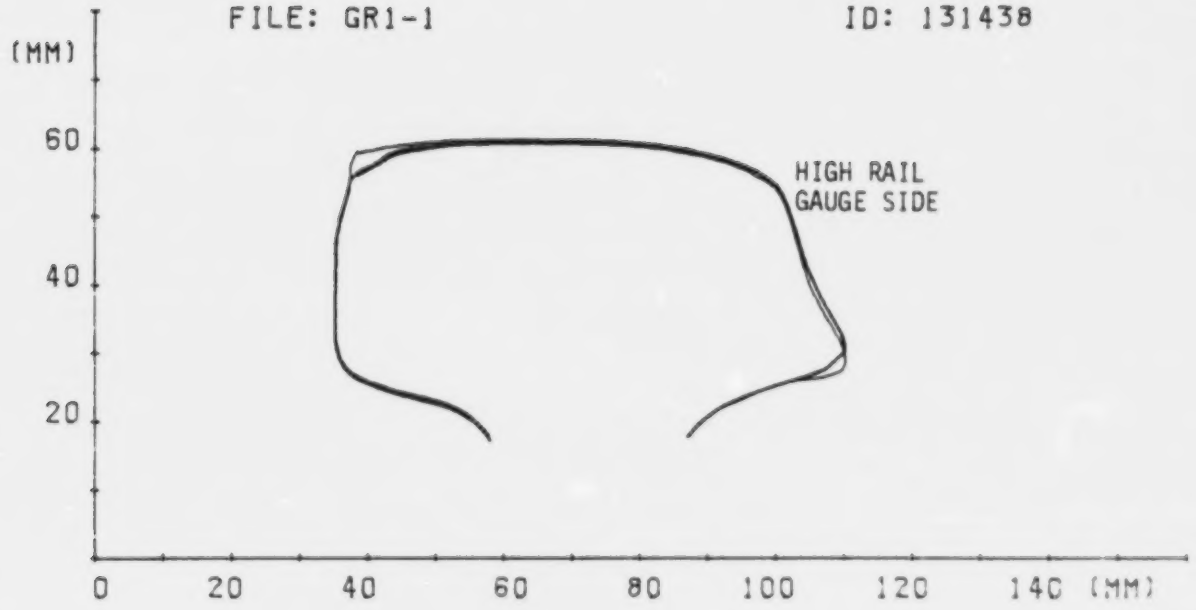


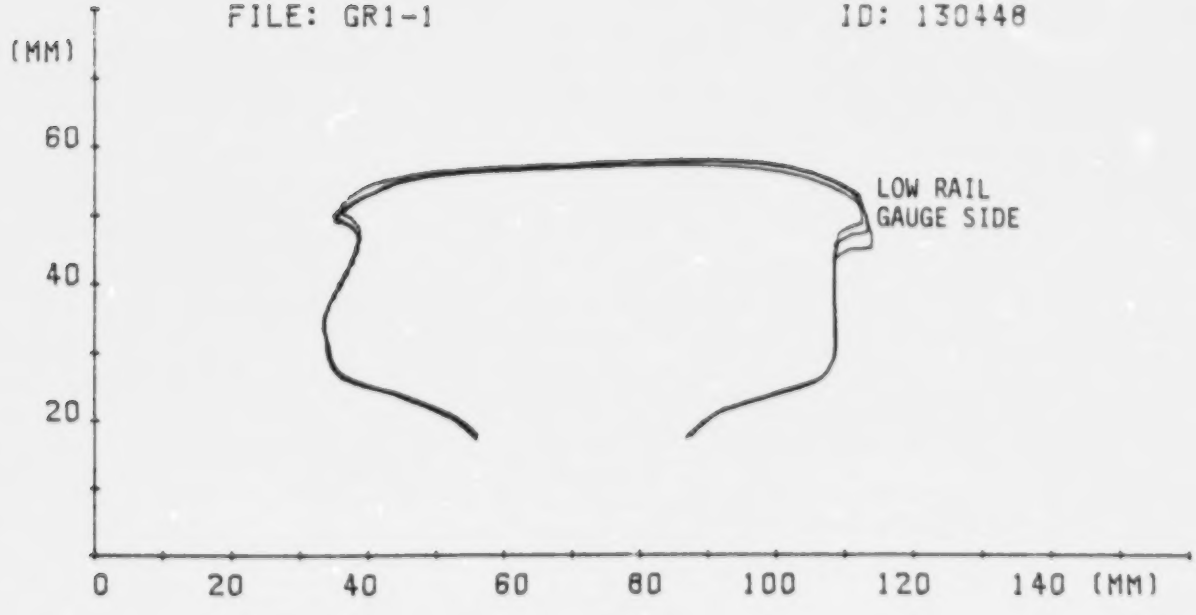
TEST SITE 2, 4 DEGREE CURVE AT MILEAGE 8.7



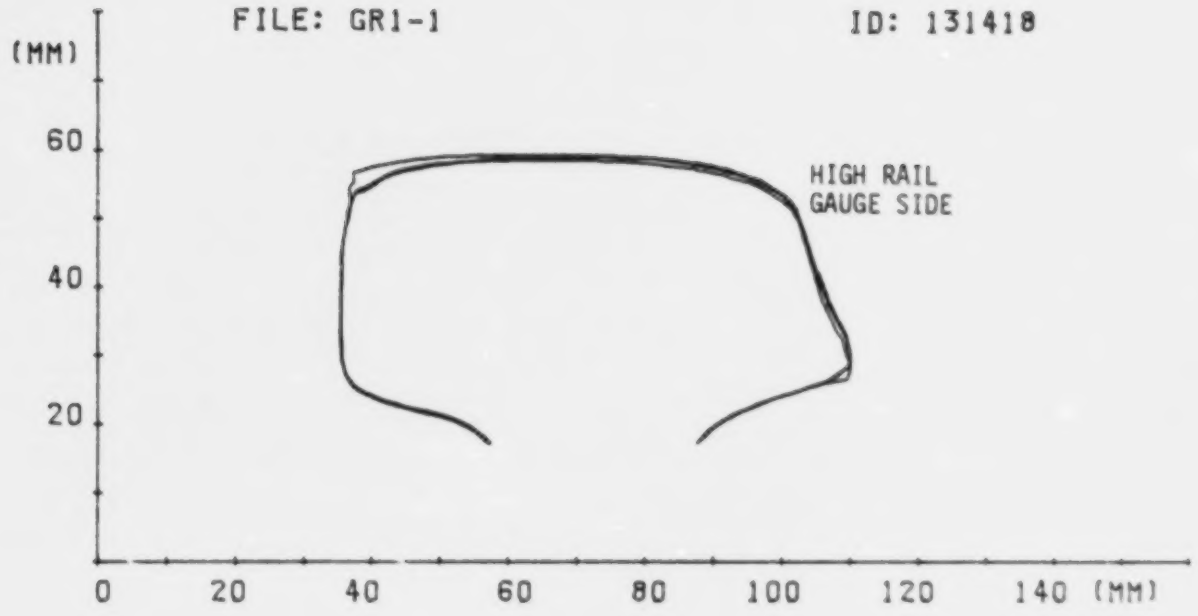


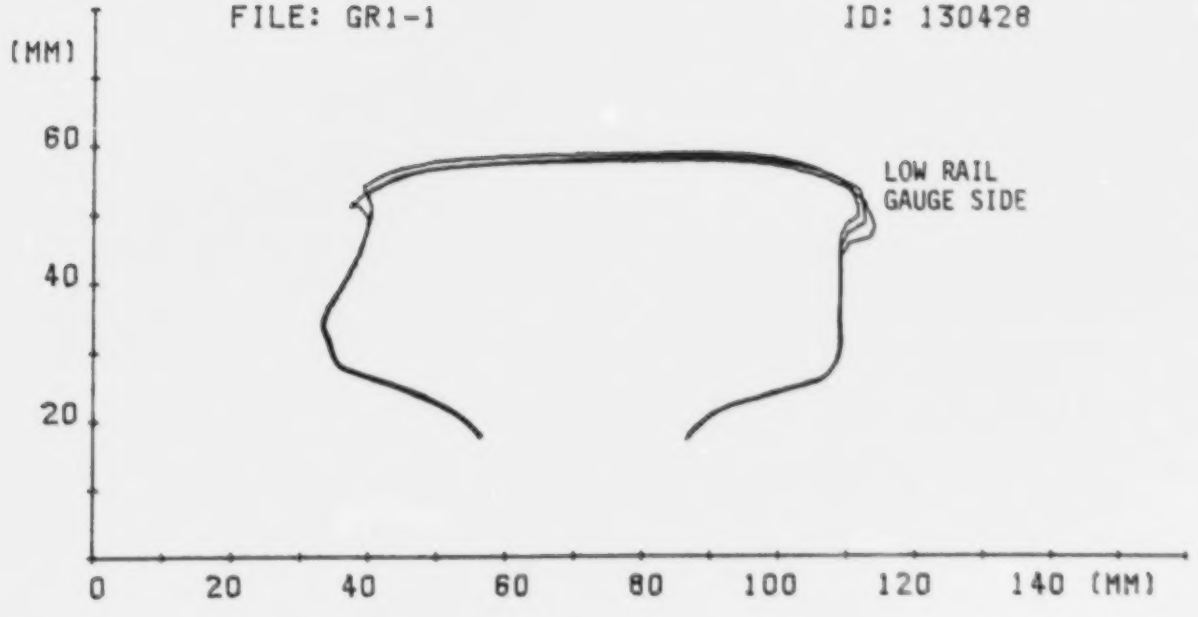
TEST SITE 2, 4 DEGREE CURVE AT MILEAGE 8.7





TEST SITE 13, 8 DEGREE CURVE AT MILEAGE 9.6

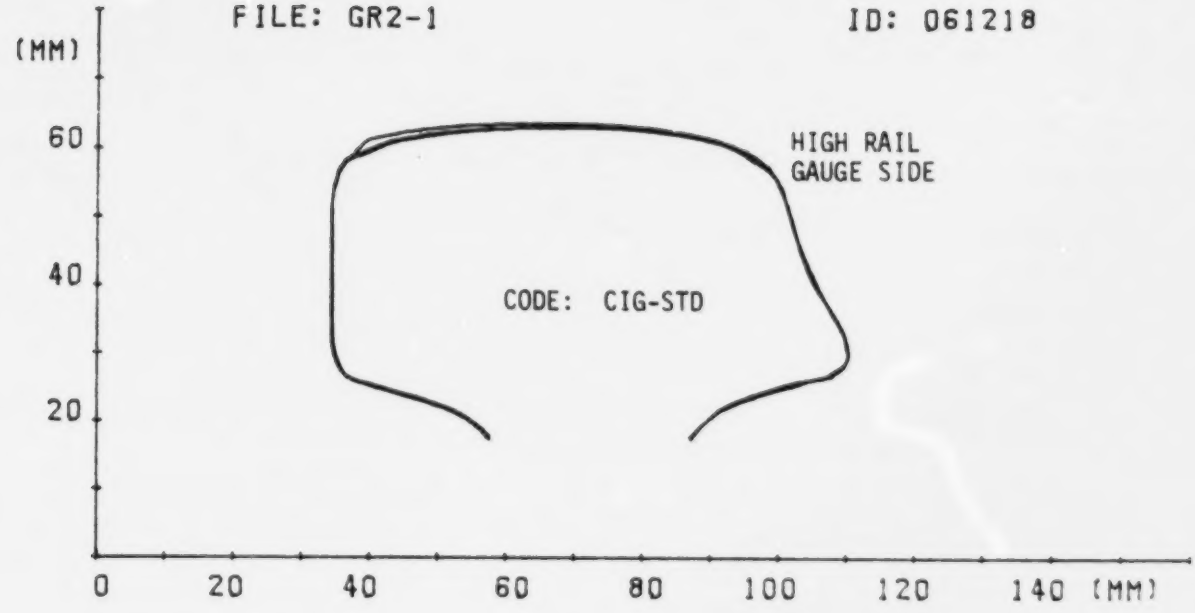


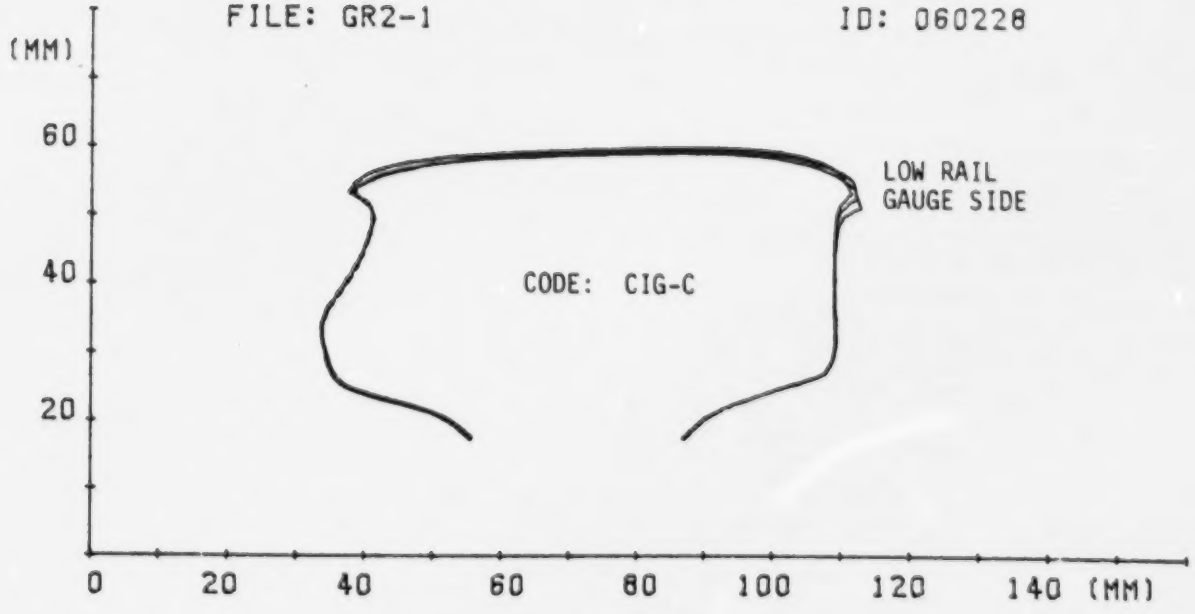


TEST SITE 13, 8 DEGREE CURVE AT MILEAGE 9.6

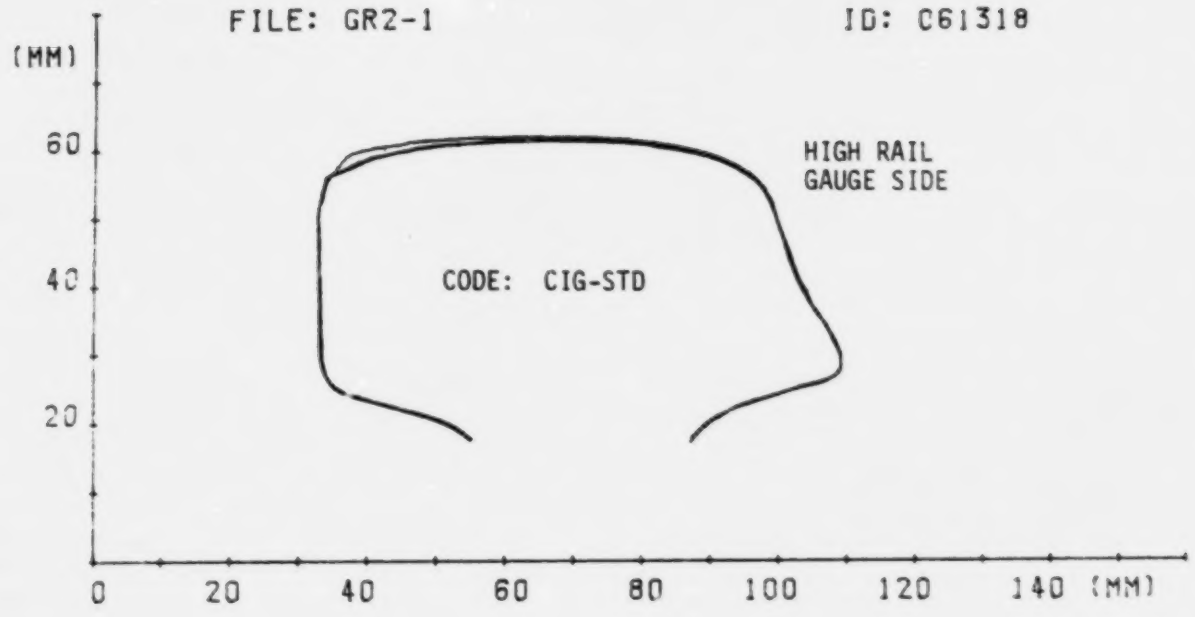
CIG-STD - Grinding for High Rail in 8° and 4° Curves

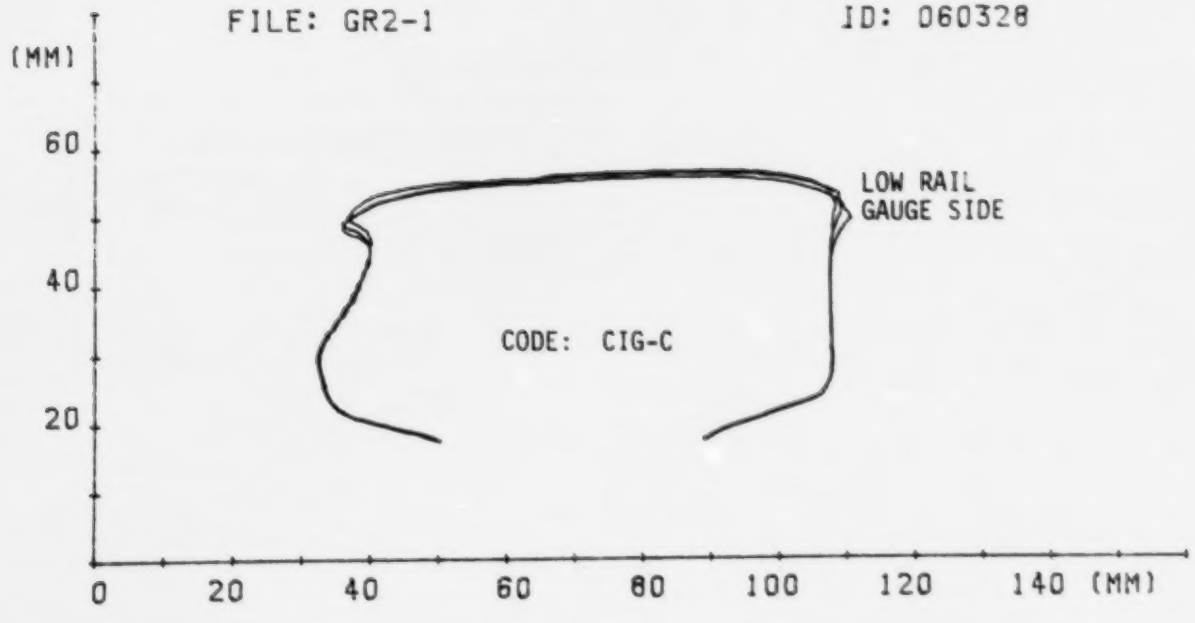
CIG-C - Grinding for Low Rail in 8° and 4° Curves



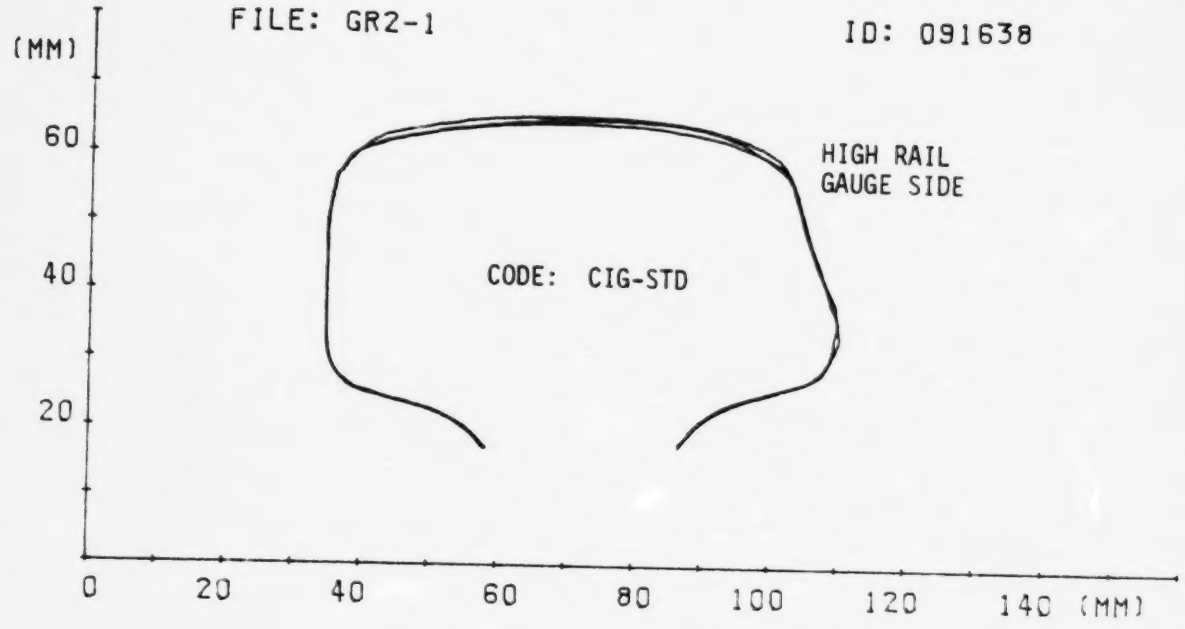


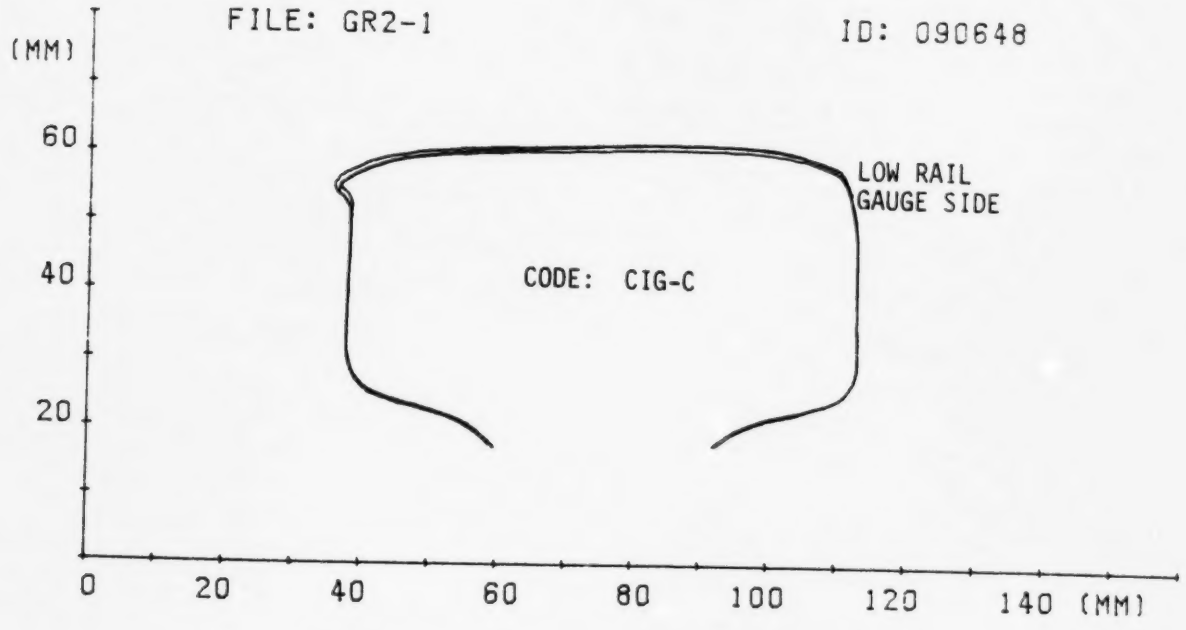
TEST SITE 6, 8 DEGREE CURVE, MILEAGE 10.6



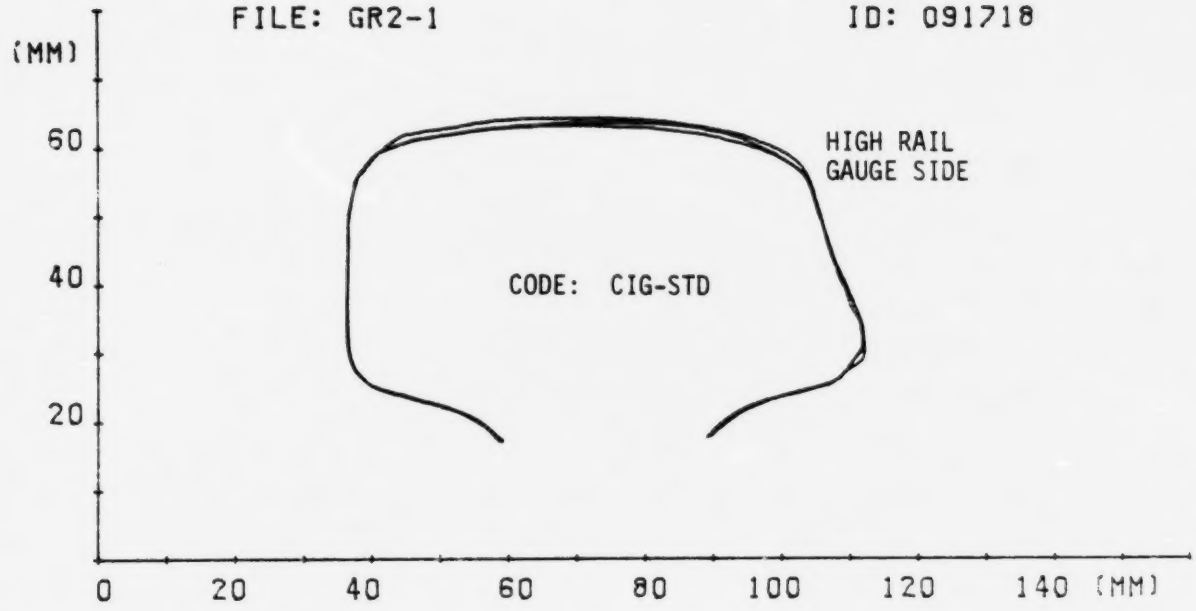


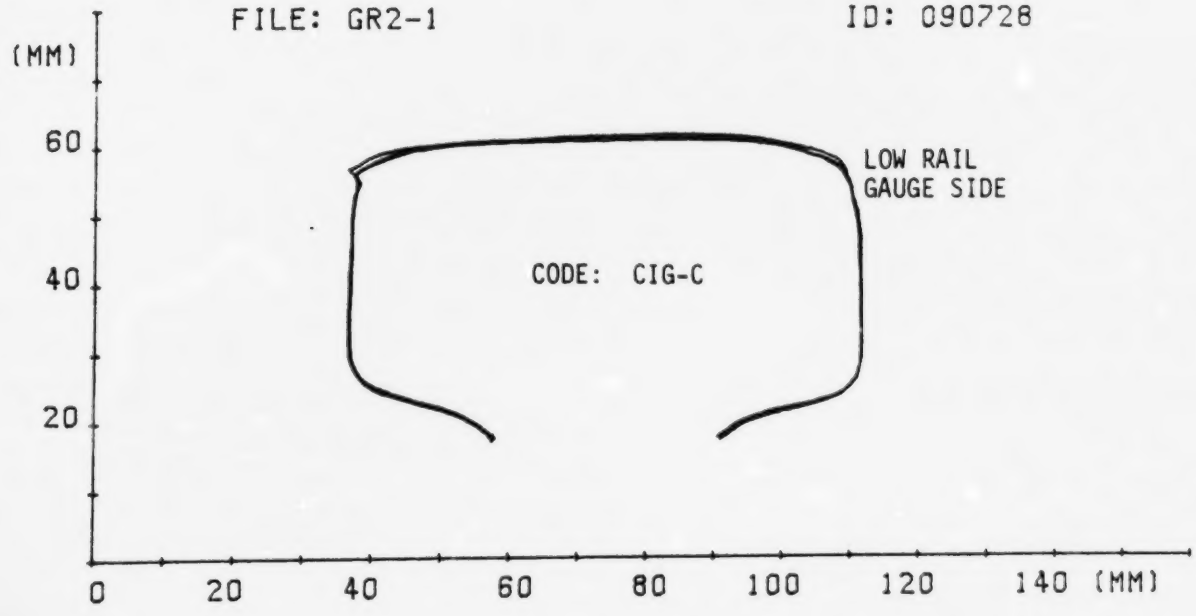
TEST SITE 6, 8 DEGREE CURVE, MILEAGE 10.6



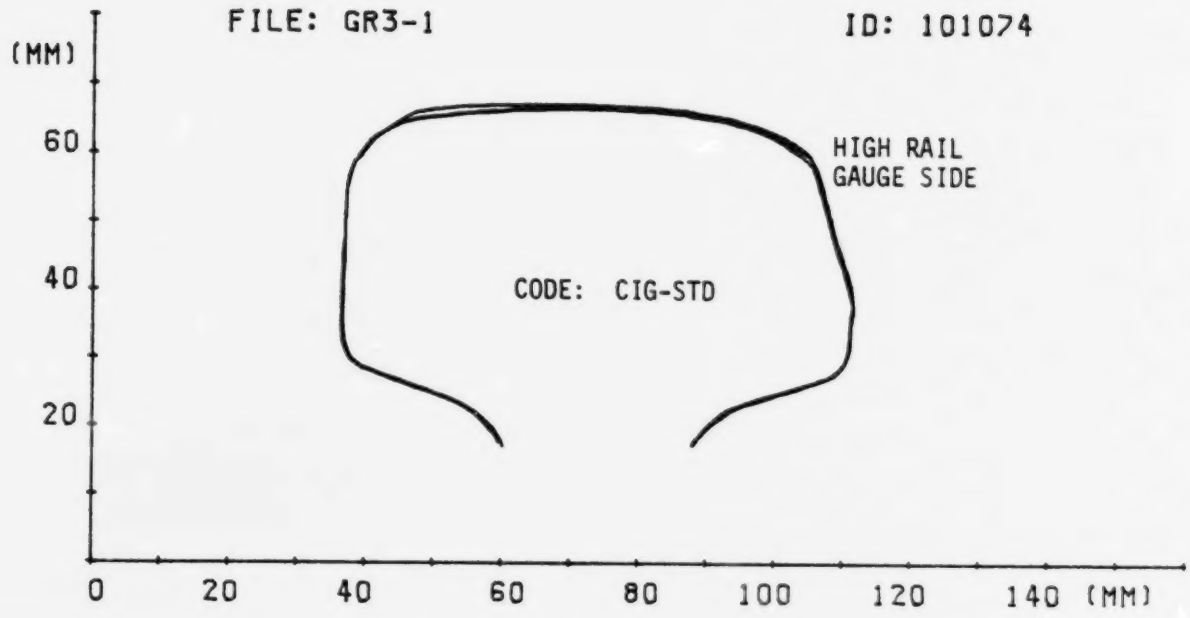


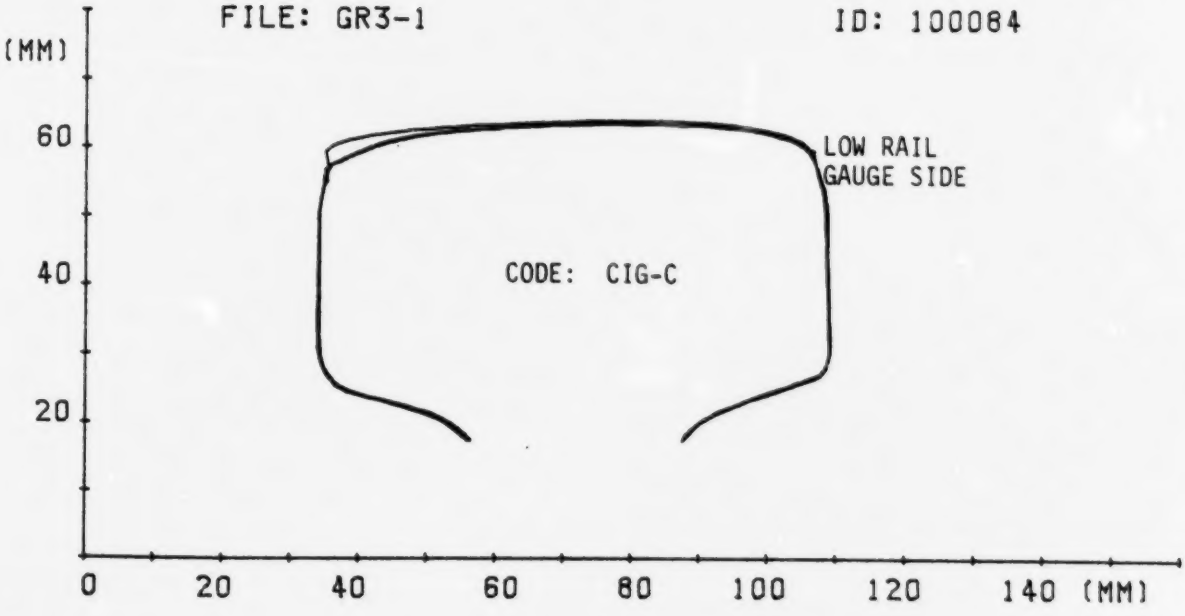
TEST SITE 9, 8 DEGREE CURVE AT MILEAGE 17.1



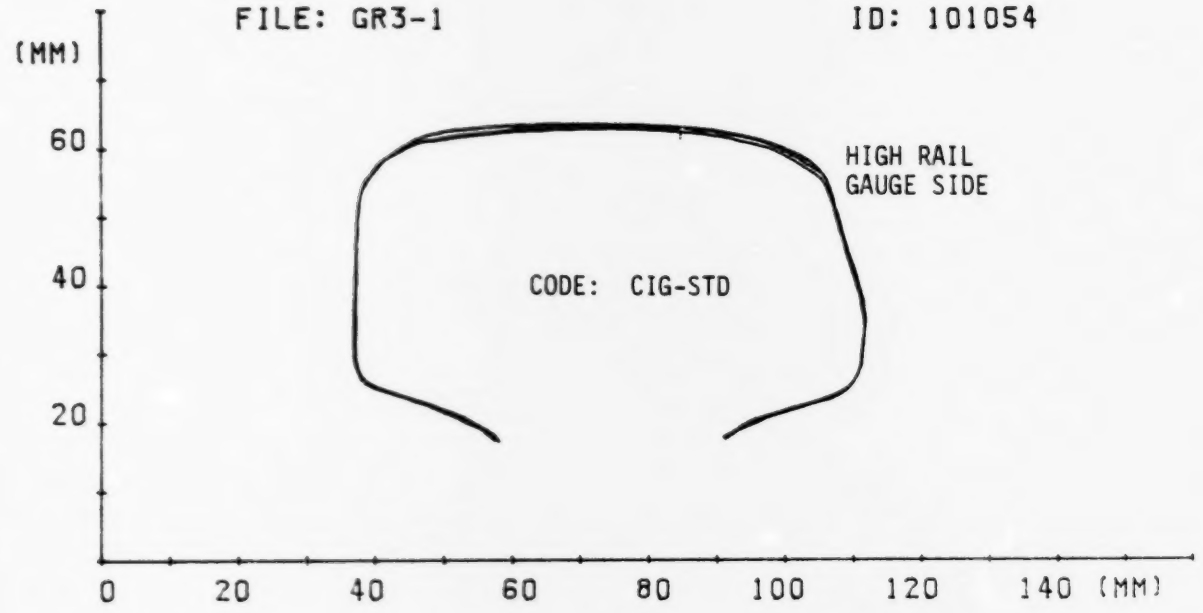


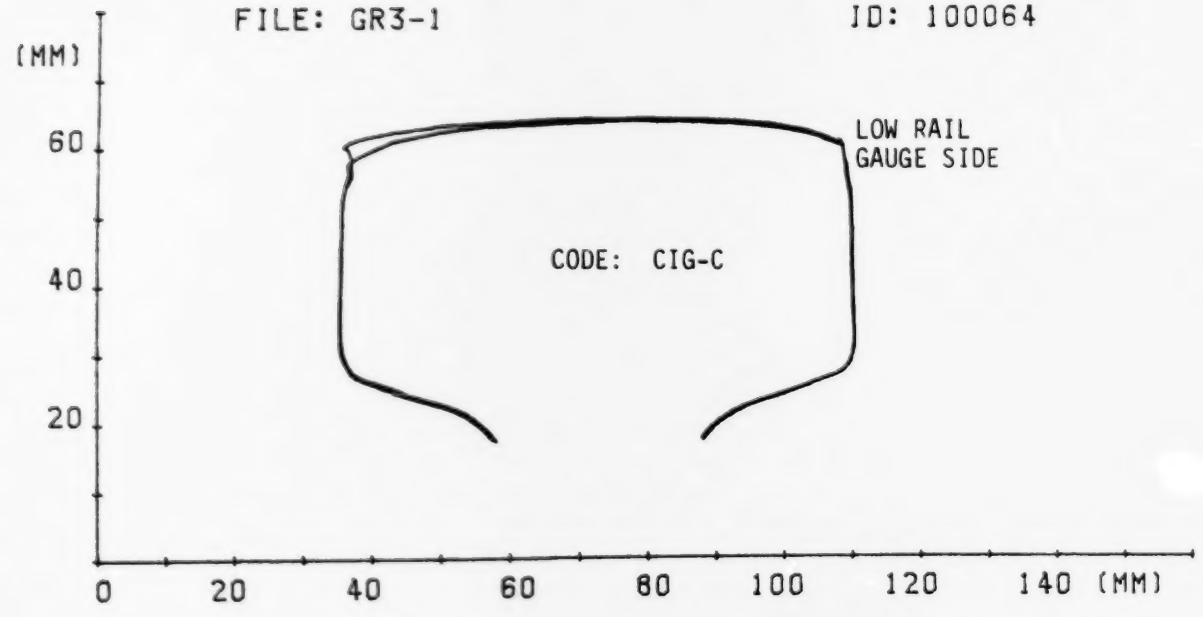
TEST SITE 9, 8 DEGREE CURVE AT MILEAGE 17.1



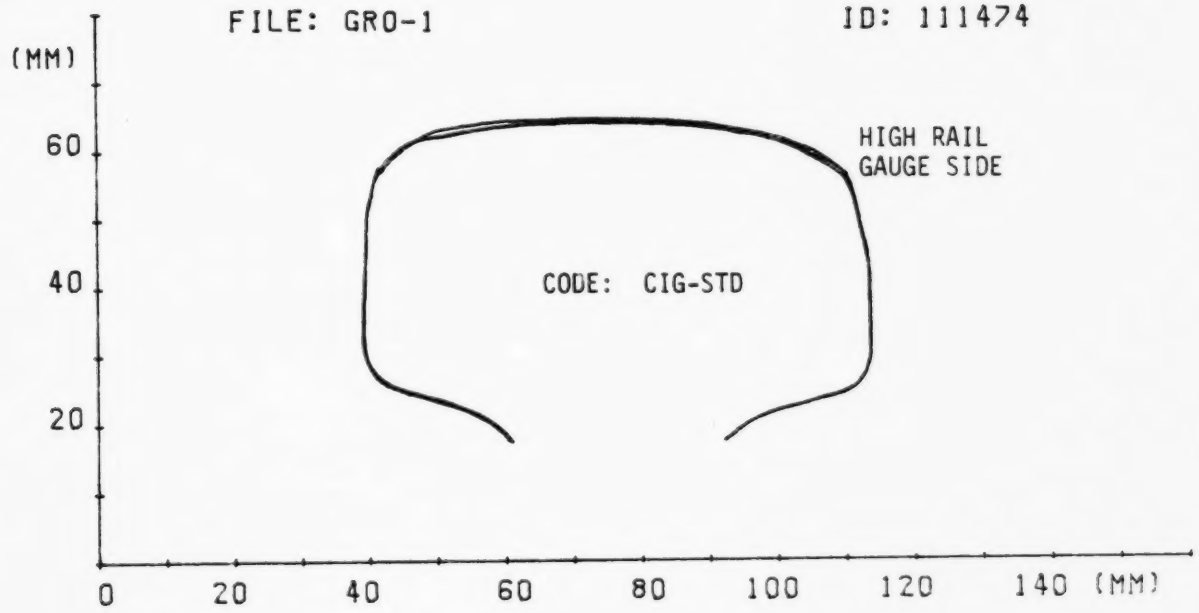


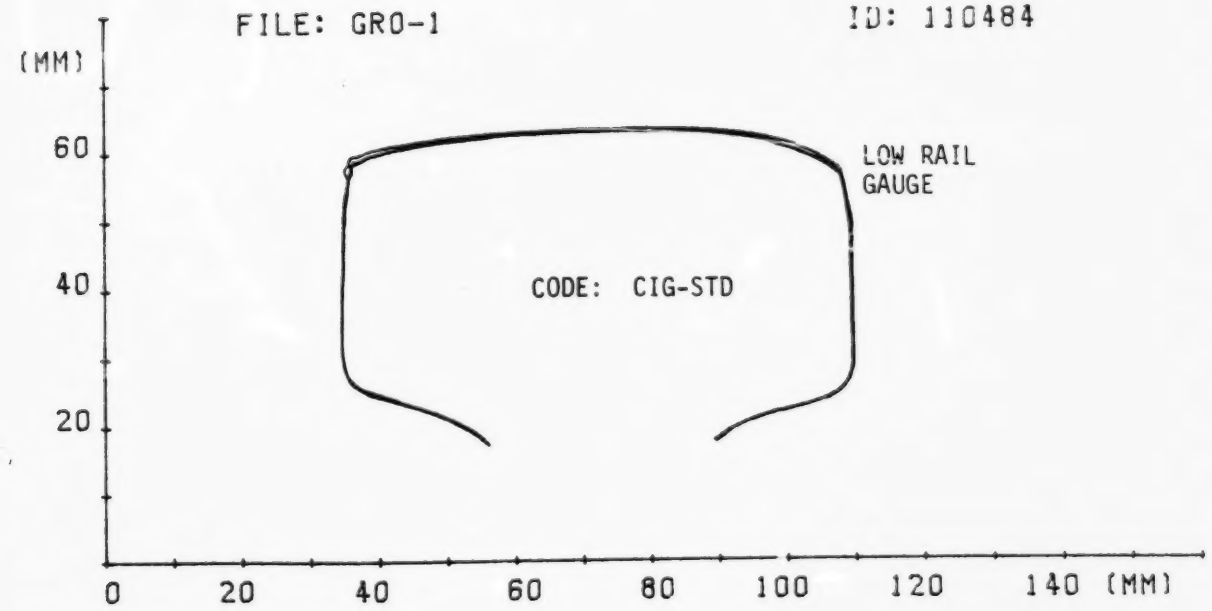
TEST SITE 10, 4 DEGREE CURVE AT MILEAGE 26.1



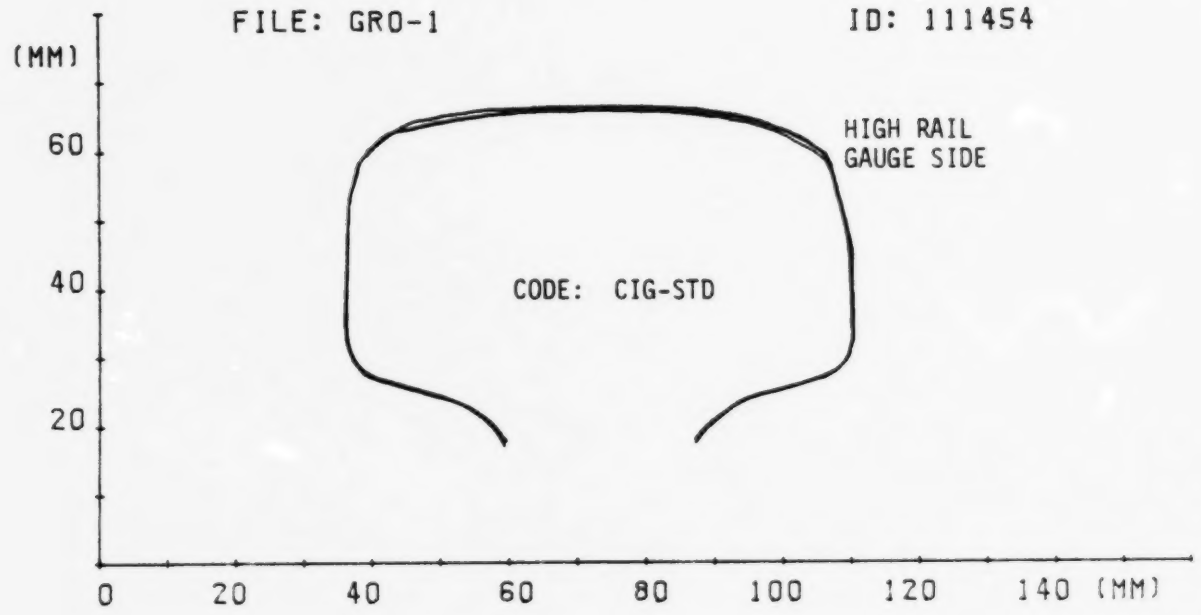


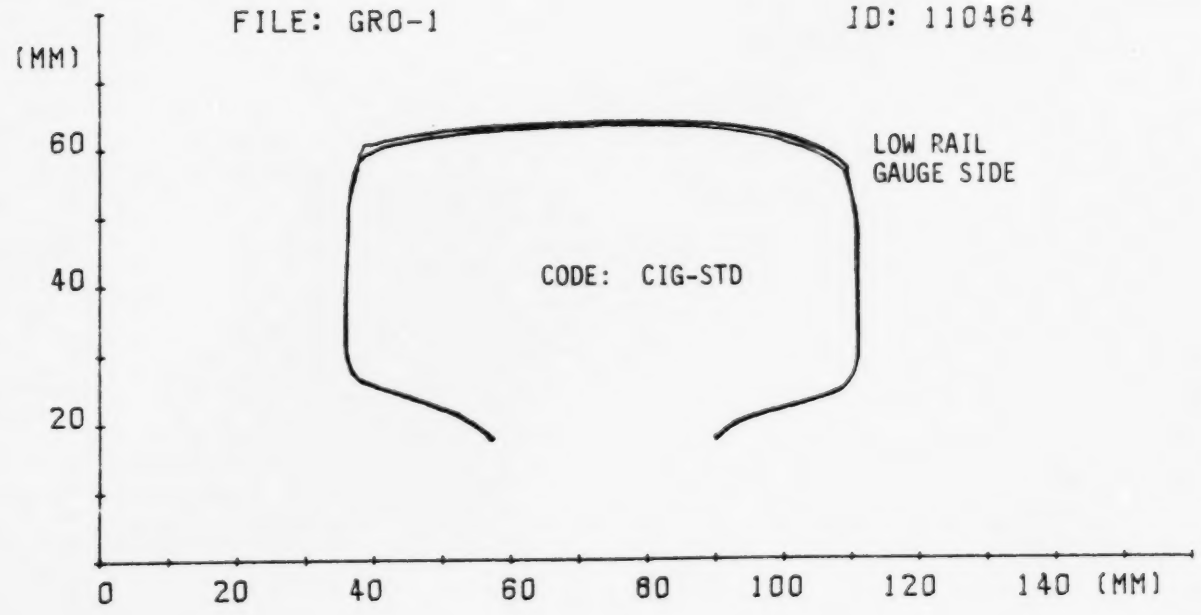
TEST SITE 10, 4 DEGREE CURVE, AT MILEAGE 26.1





TEST SITE 11, 4 DEGREE CURVE AT MILEAGE 27.1

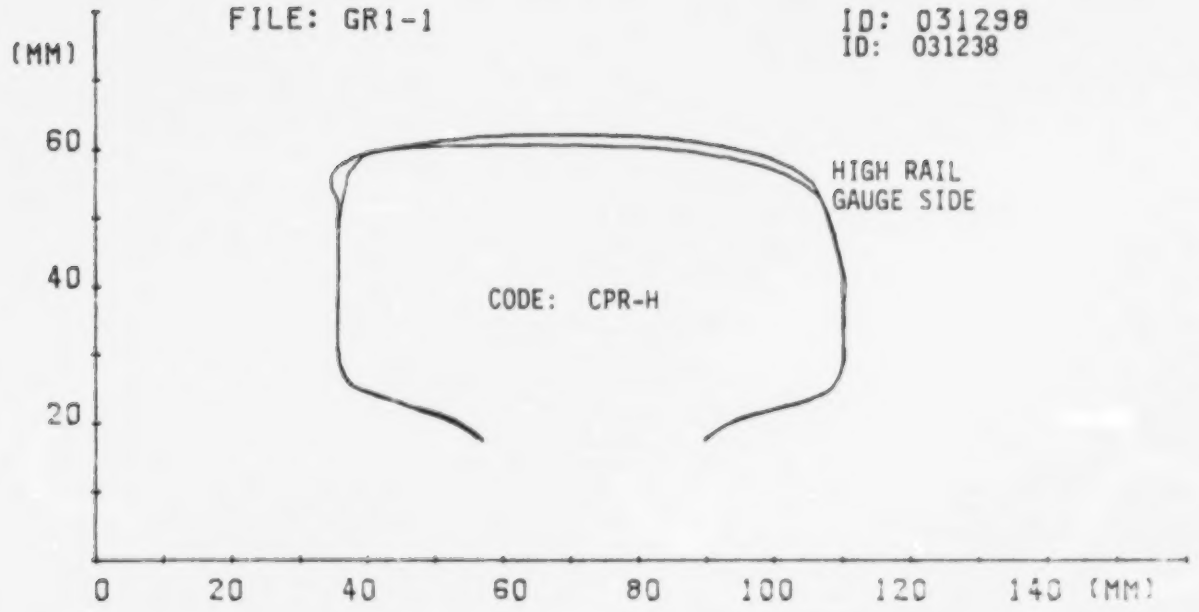


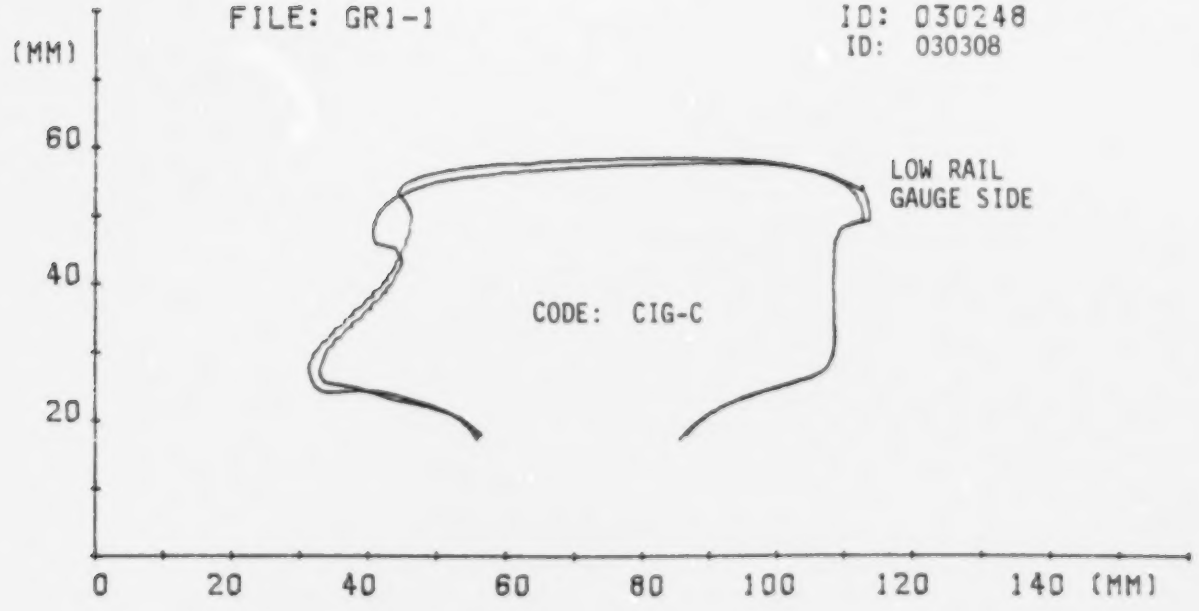


TEST SITE 11, 4 DEGREE CURVE AT MILEAGE 27.1

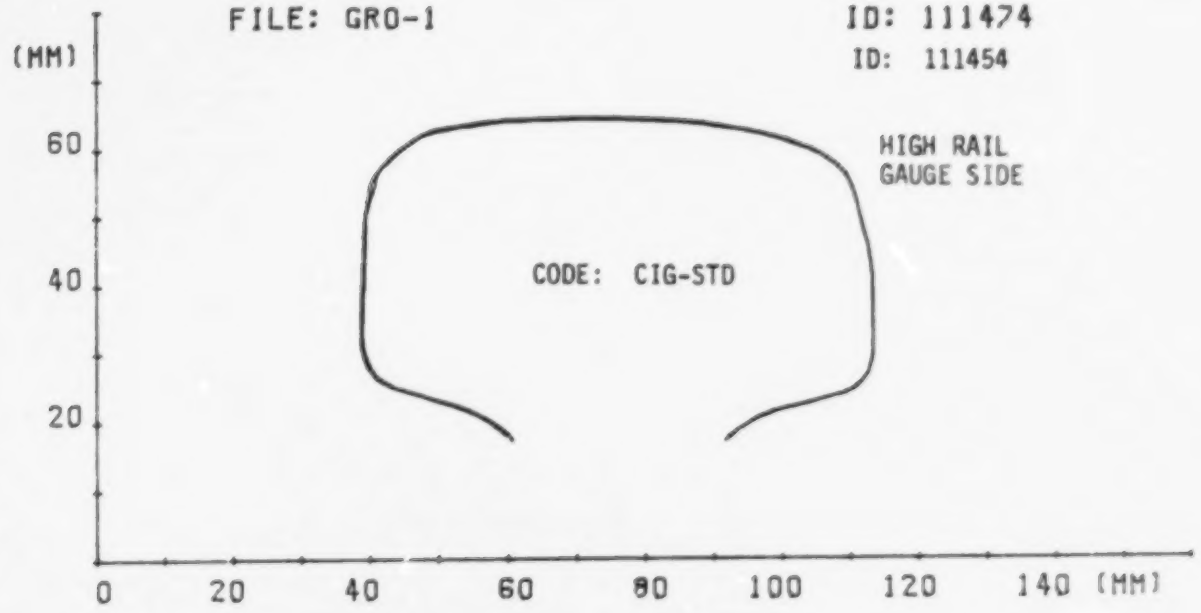
Matched Profiles for Two Locations
On the Same Curve Before Grinding

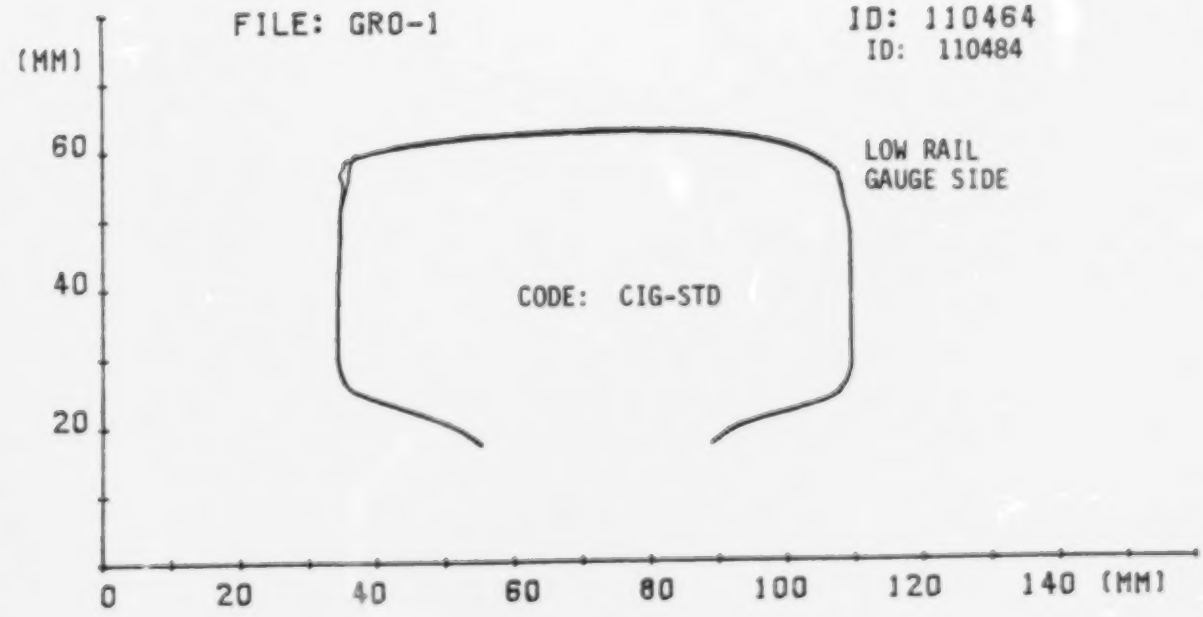
(For Test Site 3 and 11)





TEST SITE 3, MILEAGE 9.5





TEST SITE 11, MILEAGE 27.1

APPENDIX D

DETAILS OF RAIL PROFILE MEASUREMENTS IN THE TEST CURVES

RAIL PROFILE MEASUREMENTS FOR RAIL GRINDING TEST - PHASE II

Progress Summary No. 2

Planning and Research Department
CP Rail

November 15, 1984

Editorial note: This appendix contains an exact reproduction of CP Research progress summary report No. 2, "Rail Profile Measurements for Rail Grinding Test - Phase II," (November 15, 1984). The analyses and conclusions reported therein were made independently of CIGGT and do not necessarily reflect the views of this Institute or its researchers.

RAIL PROFILE MEASUREMENTS FOR RAIL GRINDING TEST - PHASE II

Progress Summary - 2

1.0 Introduction

At the request of the Steering Committee on Rail Grinding, Planning and Research carried out rail profile measurements in the 12 preselected curves on the Cascade Subdivision 16 weeks after the initial grinding. All rail profile measurements were carried out at the same locations in each curve as carried out previously.

The rail profiles taken after 10 and 16 weeks of the initial grinding were matched for the same location and are presented in Appendix I.

2.0 Observations on Rail Grinding Profile Measurements 16 Weeks After Grinding (Approximately 18 million gross tons)

No wear data is reported as the matched profiles showed there was very little wear that occurred after sixteen weeks irrespective of the type of rail grinding pattern.

As previously reported the high rail gauge side in the 4° and 8° curves that were ground to the CIG-STD, CN-H and CPR-H grinding patterns had returned to their original worn contours after 10 weeks (11 million gross tons). There was no further change to the high rail gauge side profile at 16 weeks (18 million gross tons) irrespective of the type of grinding.

The field side of the high rail in the 4° and 8° curves ground by the CIG-STD, CN-H, CPR-H grinding methods retained their grinding pattern.

The short heavy taper on the field side of the low rail due to grinding with the CN-L profile was retained in most cases for the 4° and 8° curves but in some cases metal flow occurred. The low rail gauge side taper was retained.

For the CIG-C grinding profile in the 4° and 8° curves there was no further change on the low rail field side once it returned to its initial worn contour. In cases where the rail was ground with a heavy taper on the field of the low rail, the taper was retained. On the low rail gauge side the rail generally wore parallel to its original contour.

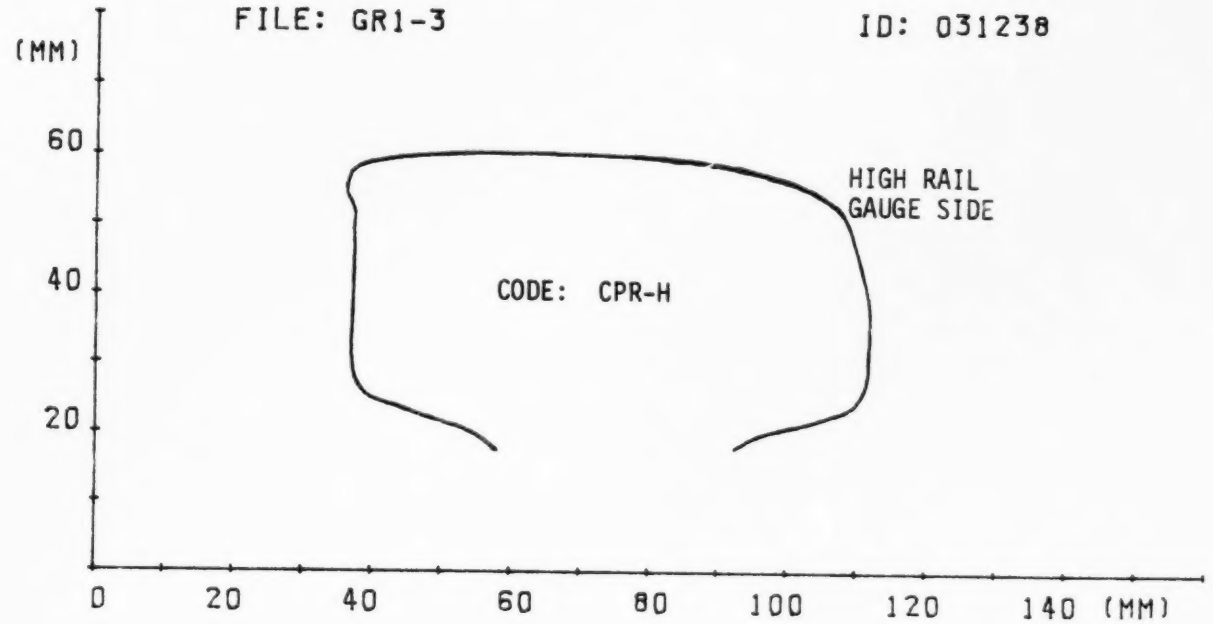
Appendix 1

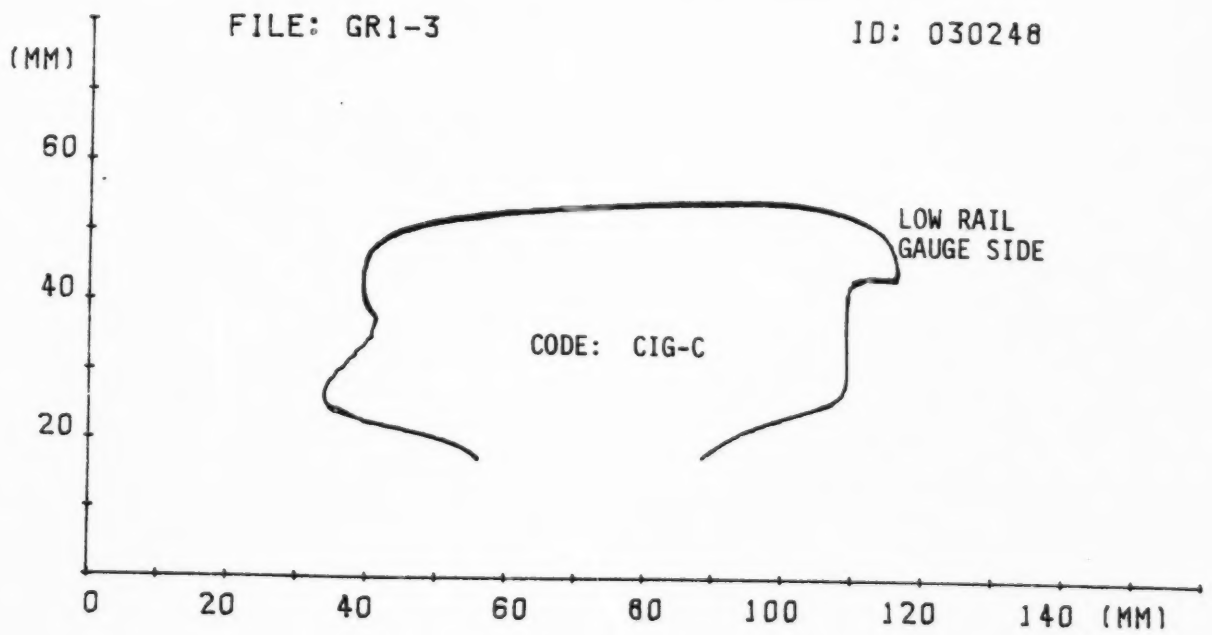
Matched Rail Profiles 10 and 16 Weeks After Grinding

CPR-H - Grinding for High Rail in 8° and 4° Curves

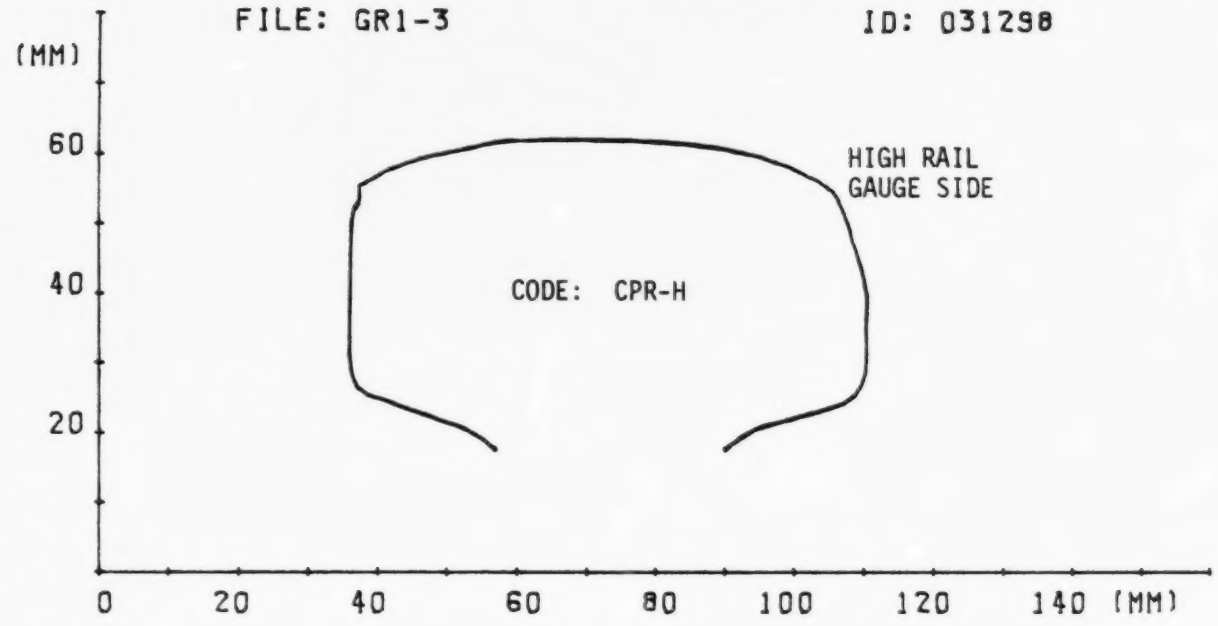
CN-L - Grinding for Low Rail in 8° and 4° Curves

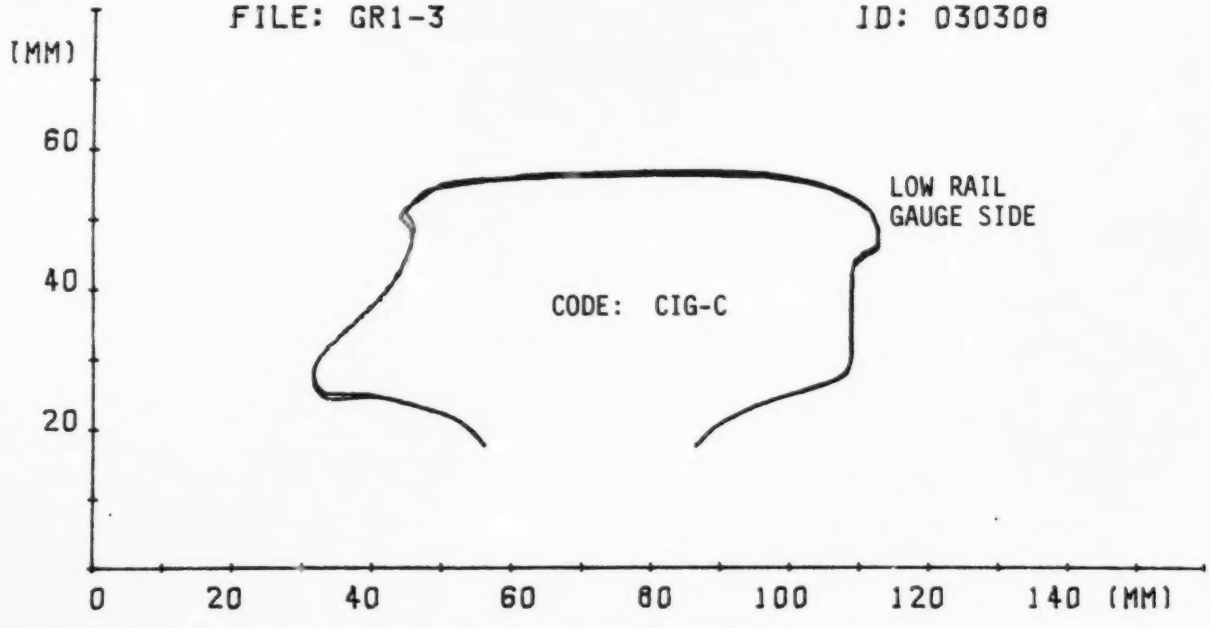
CIG-C - Grinding for Low Rail in 8° and 4° Curves



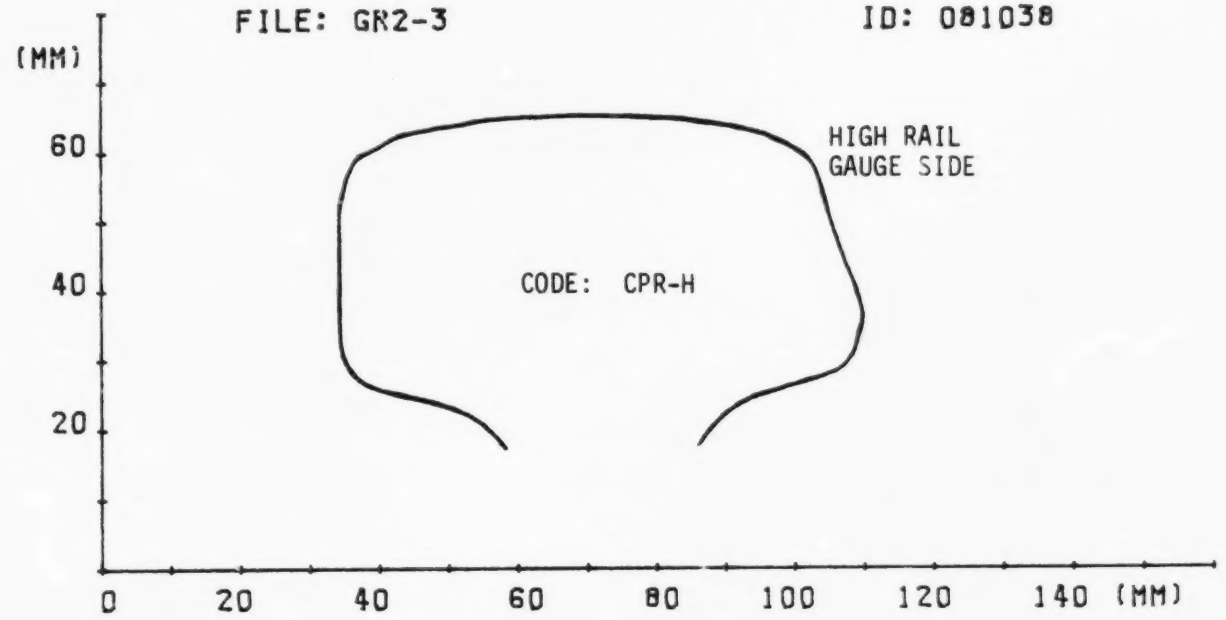


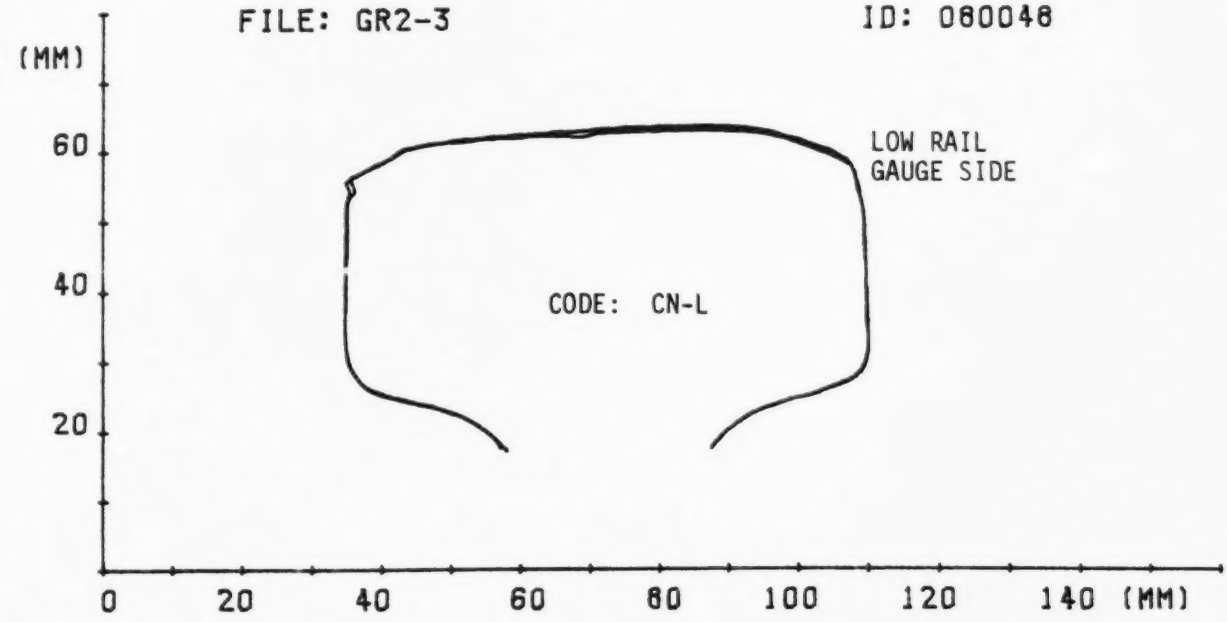
TEST SITE 3, 8 DEGREE CURVE, MILEAGE 9.5



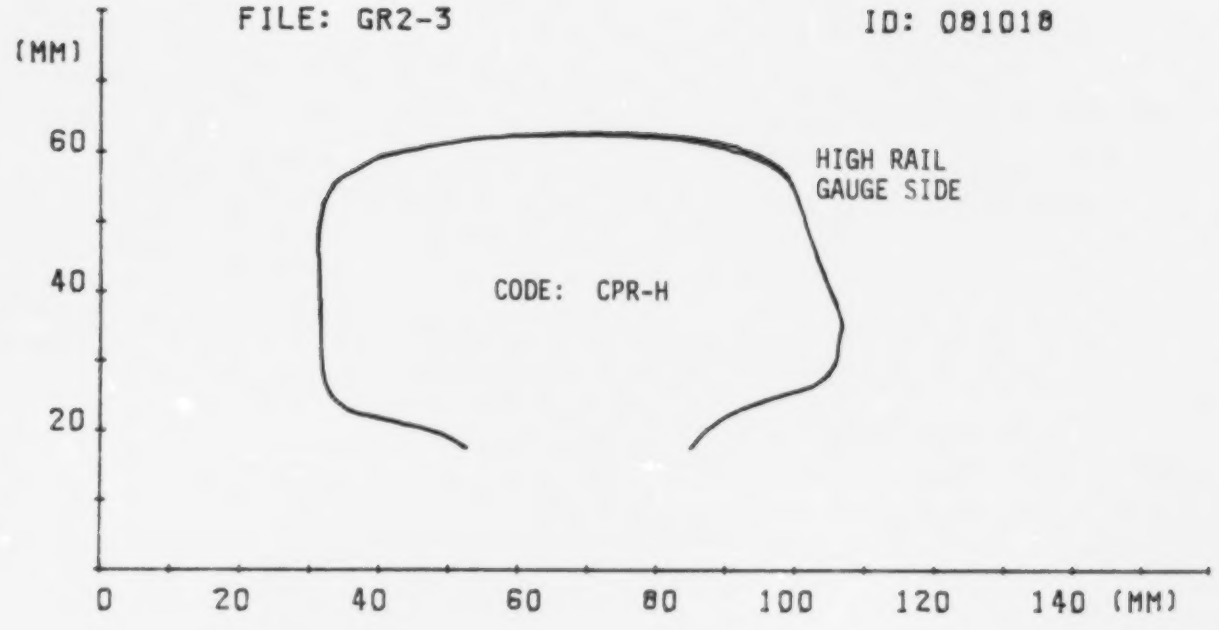


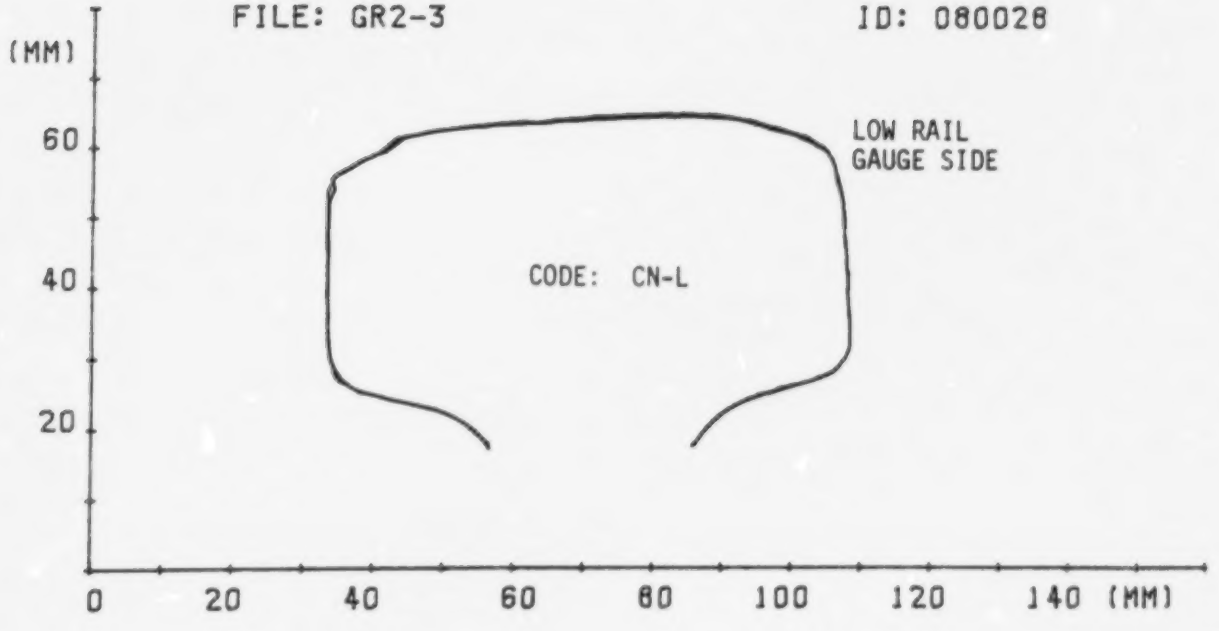
TEST SITE 3, 8 DEGREE CURVE, MILEAGE 9.5



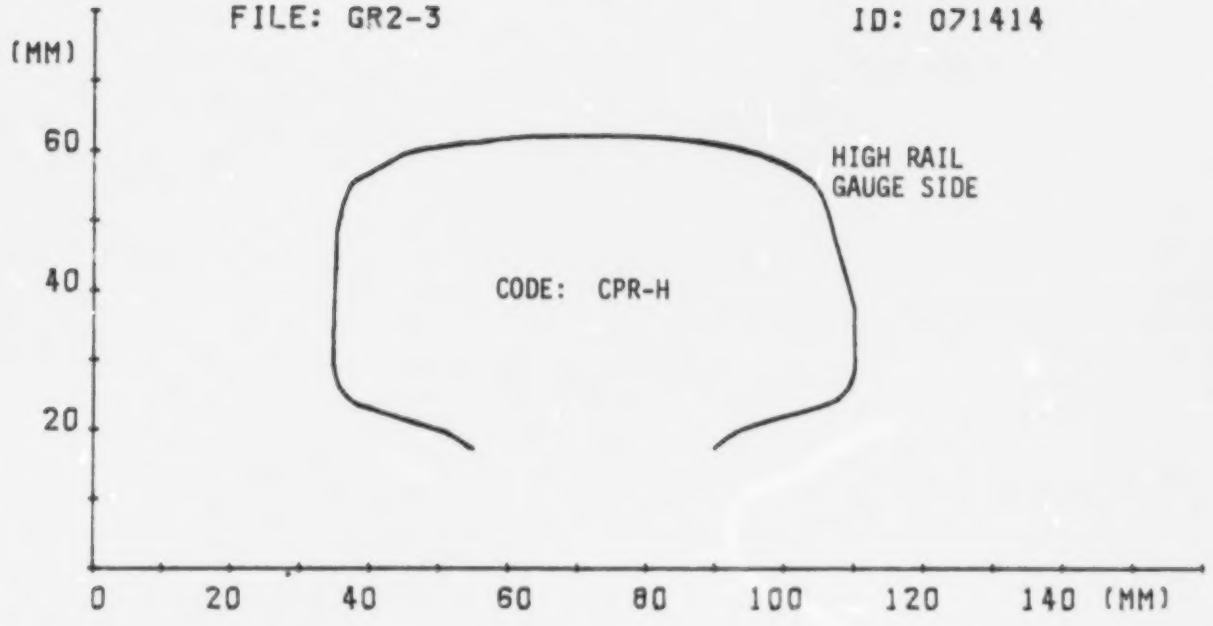


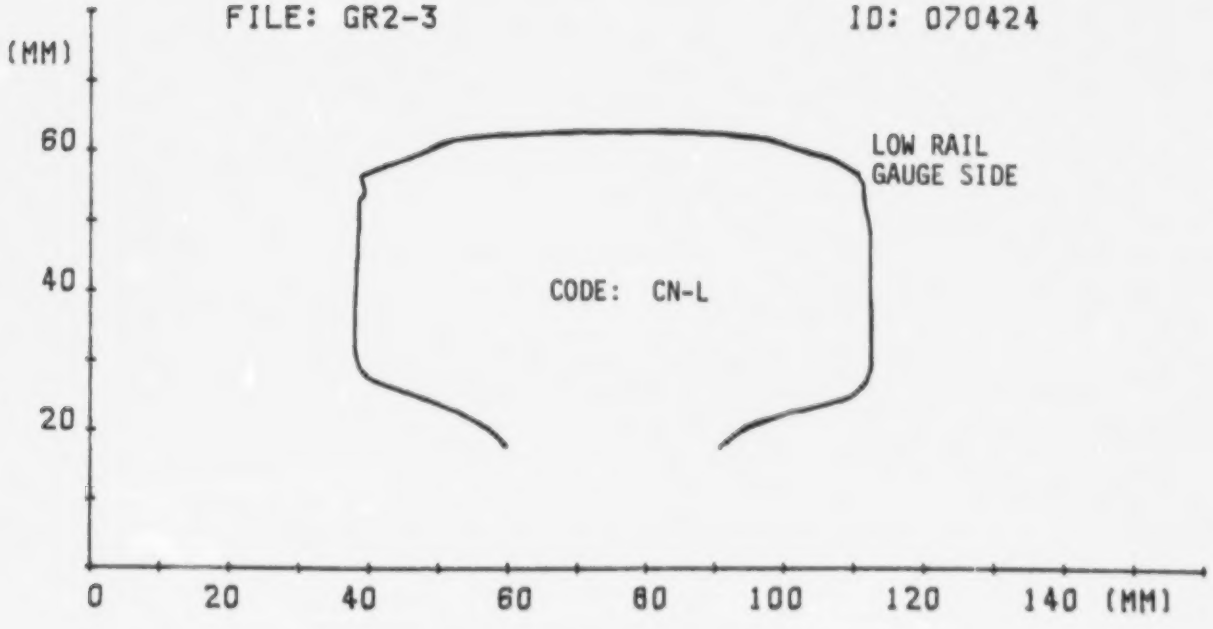
TEST SITE 8, 8 DEGREE CURVE AT MILEAGE 17



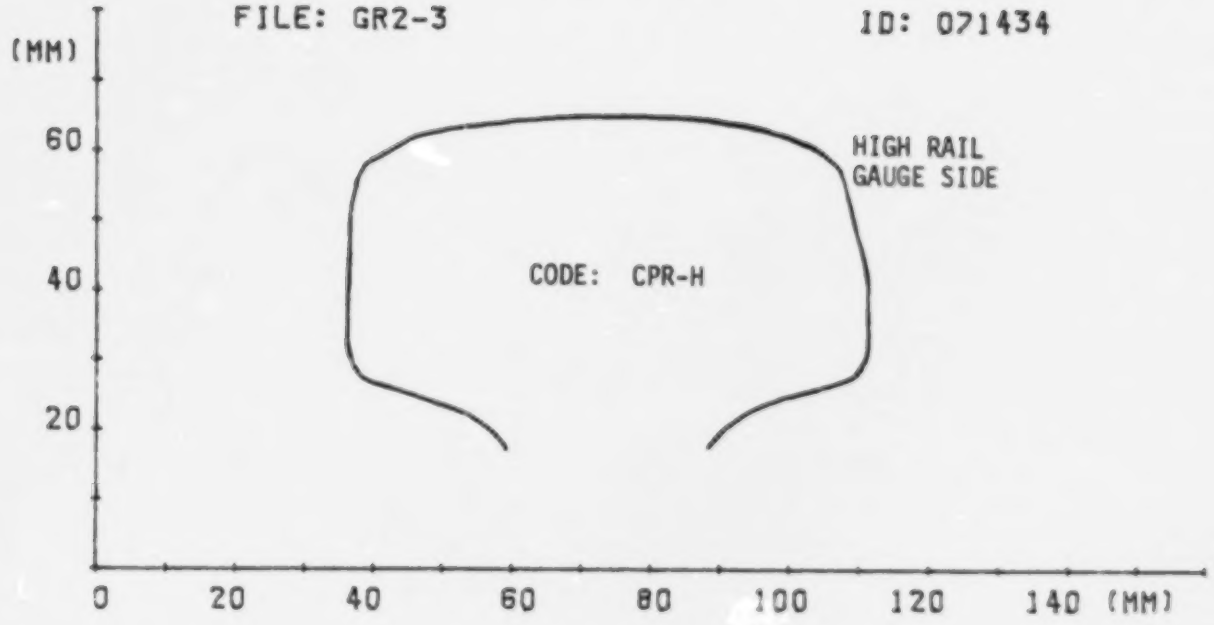


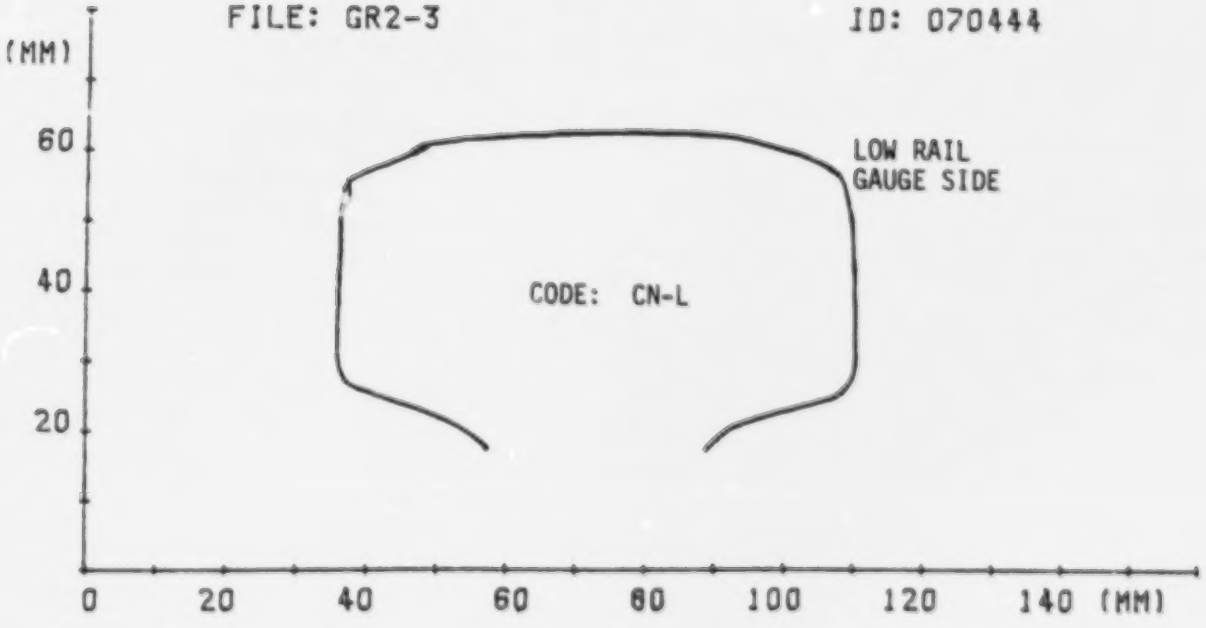
TEST SITE 8, 8 DEGREE CURVE AT MILEAGE 17



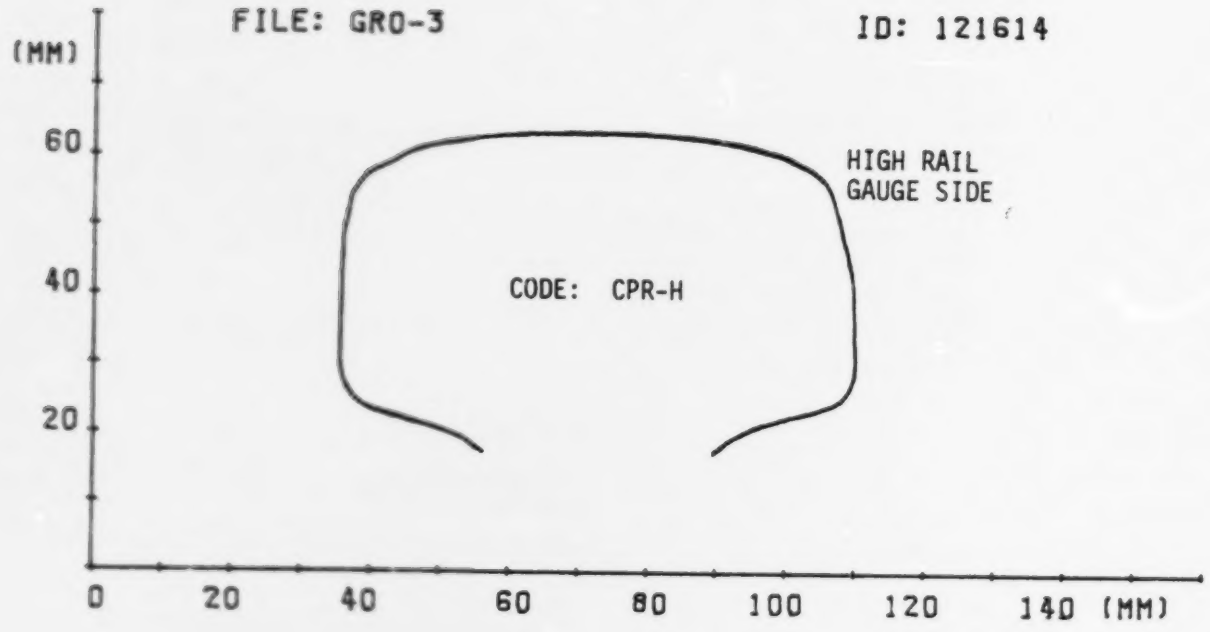


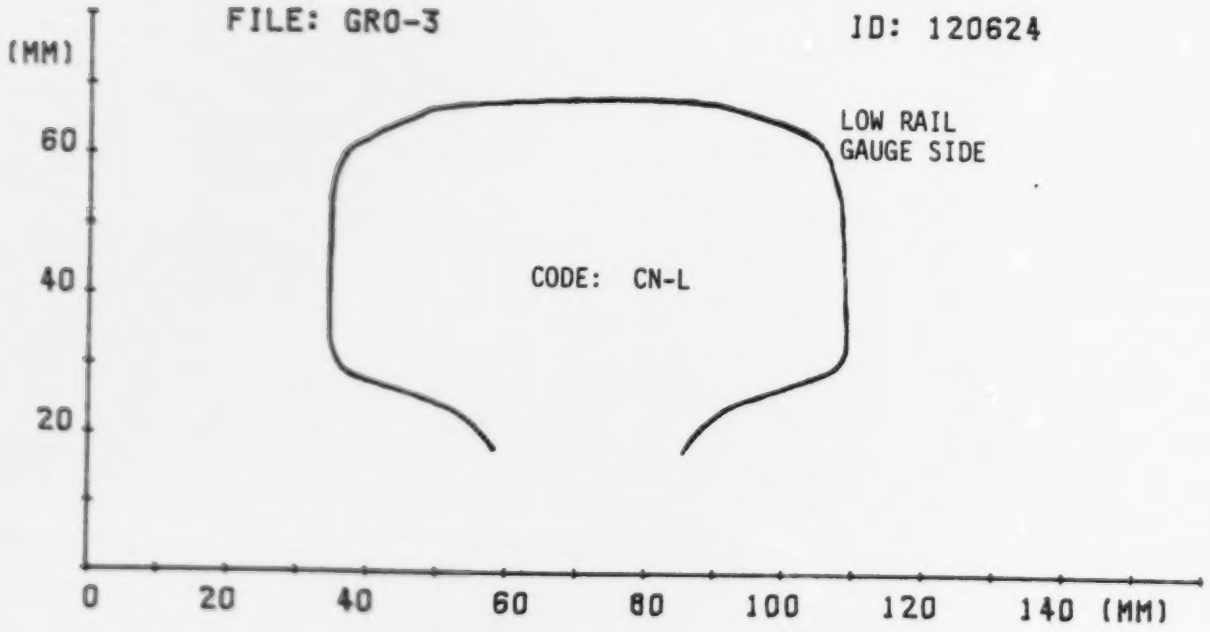
TEST SITE 7, 4 DEGREE CURVE, AT MILEAGE 13.4



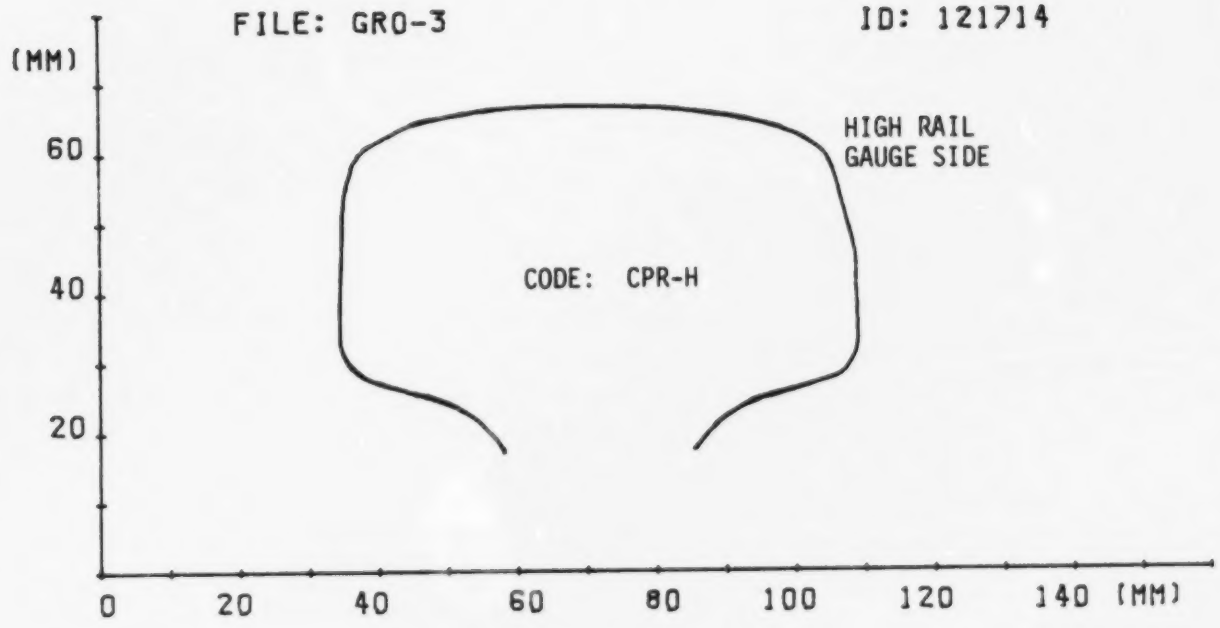


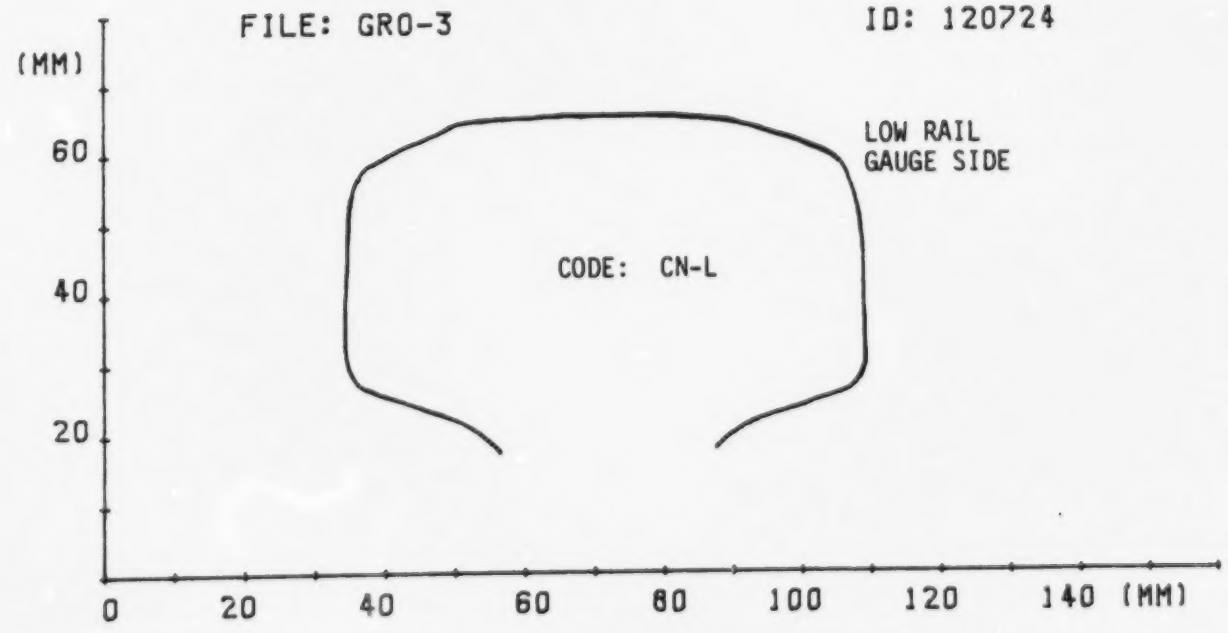
TEST SITE 7, 4 DEGREE CURVE AT MILEAGE 13.4





TEST SITE 12, 4 DEGREE CURVE AT MILEAGE 27.4

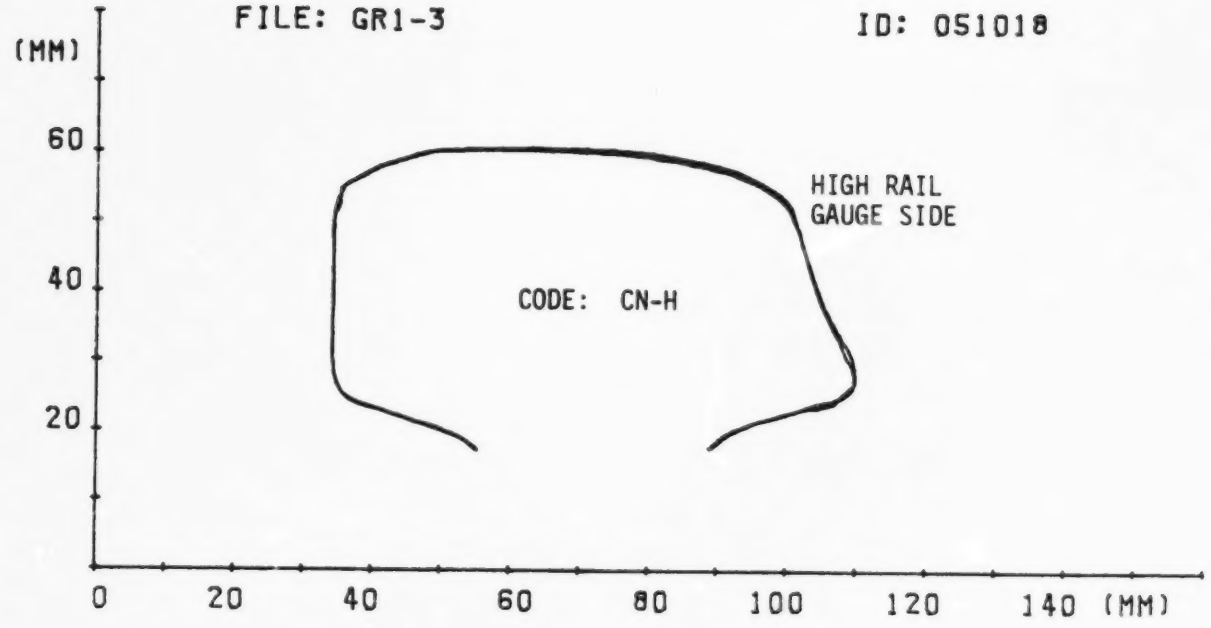


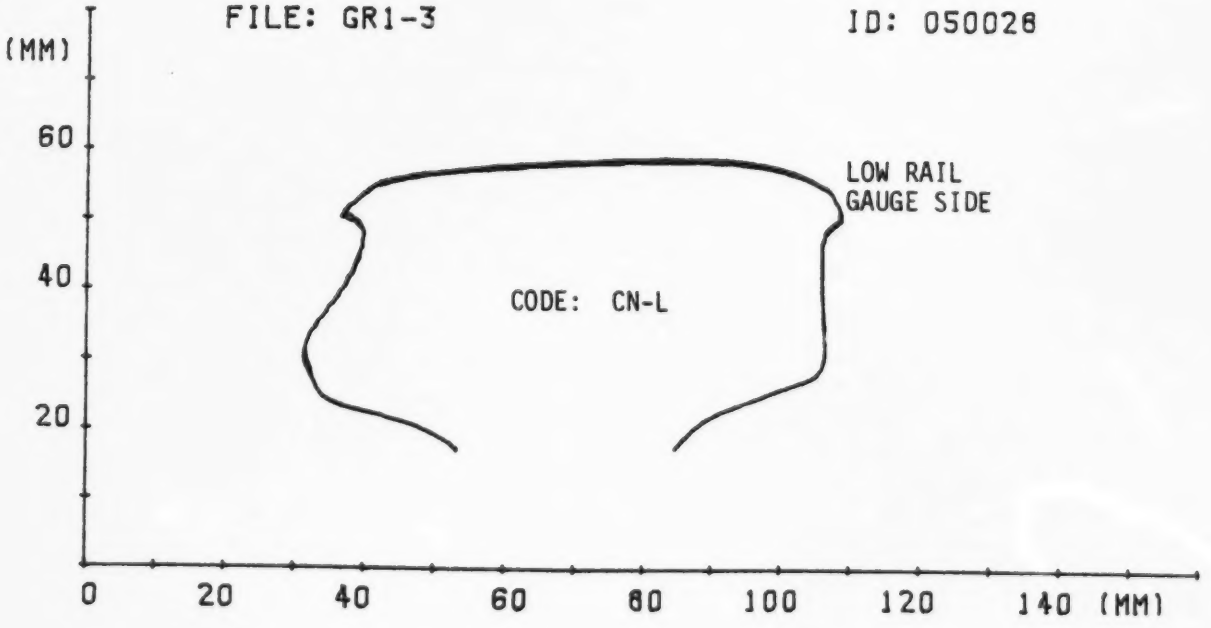


TEST SITE 12, 4 DEGREE CURVE AT MILEAGE 27.4

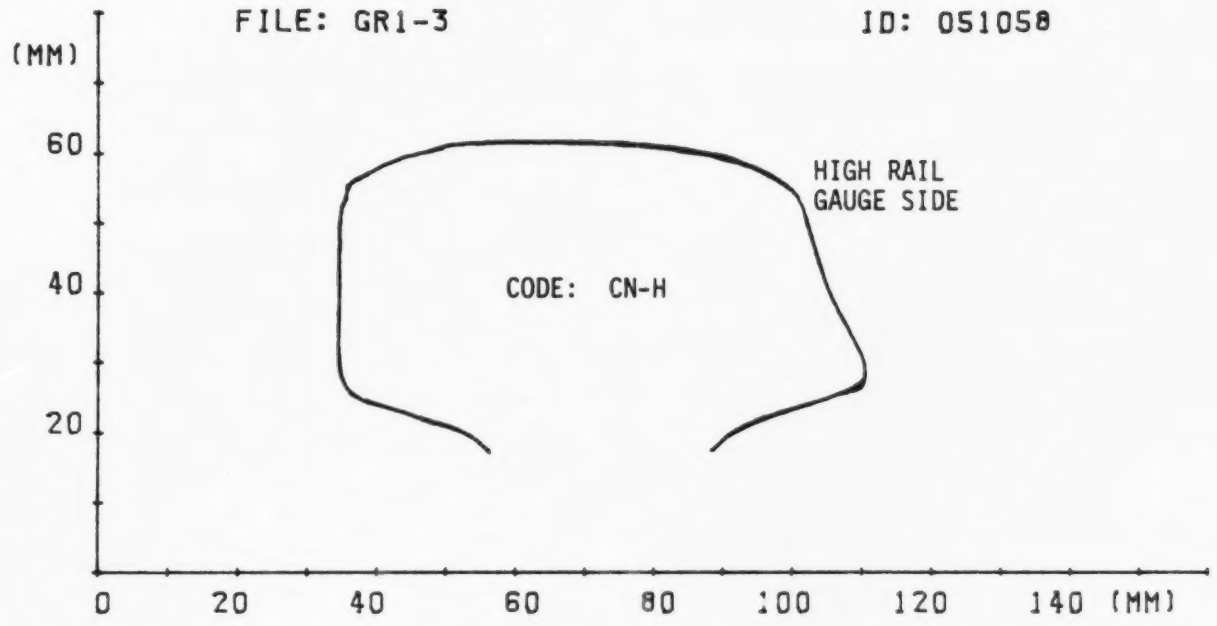
CN-H - Grinding for High Rail in 8° and 4° Curves

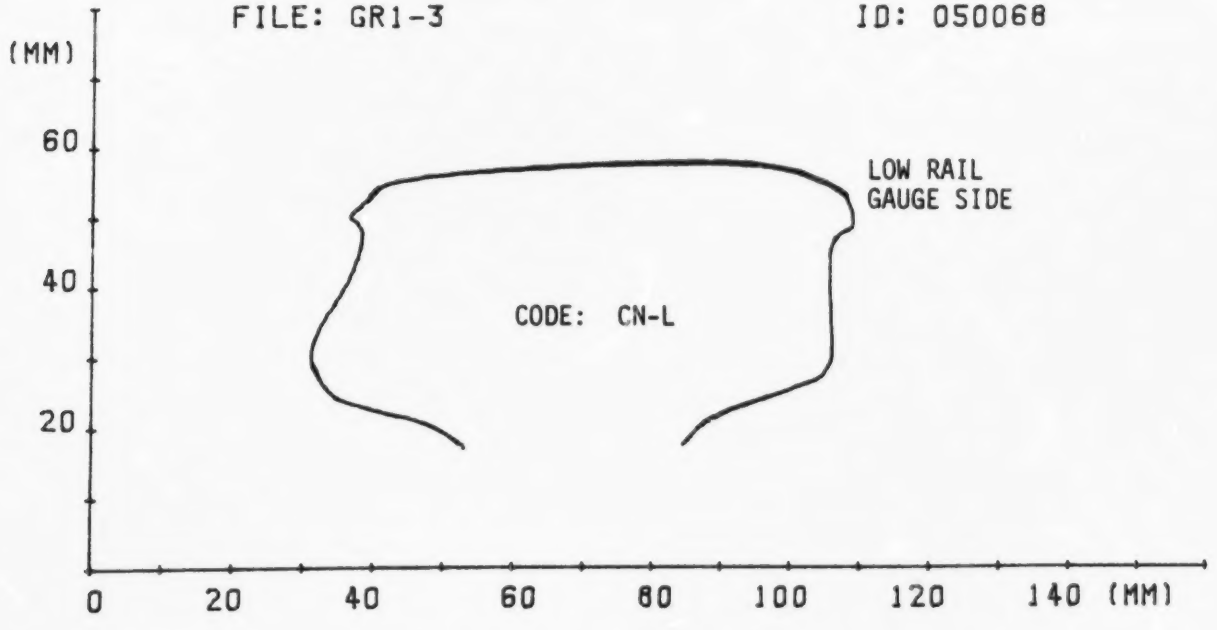
CN-L - Grinding for Low Rail in 8° and 4° Curves





TEST SITE 5, 8 DEGREE CURVE AT MILEAGE 10.5





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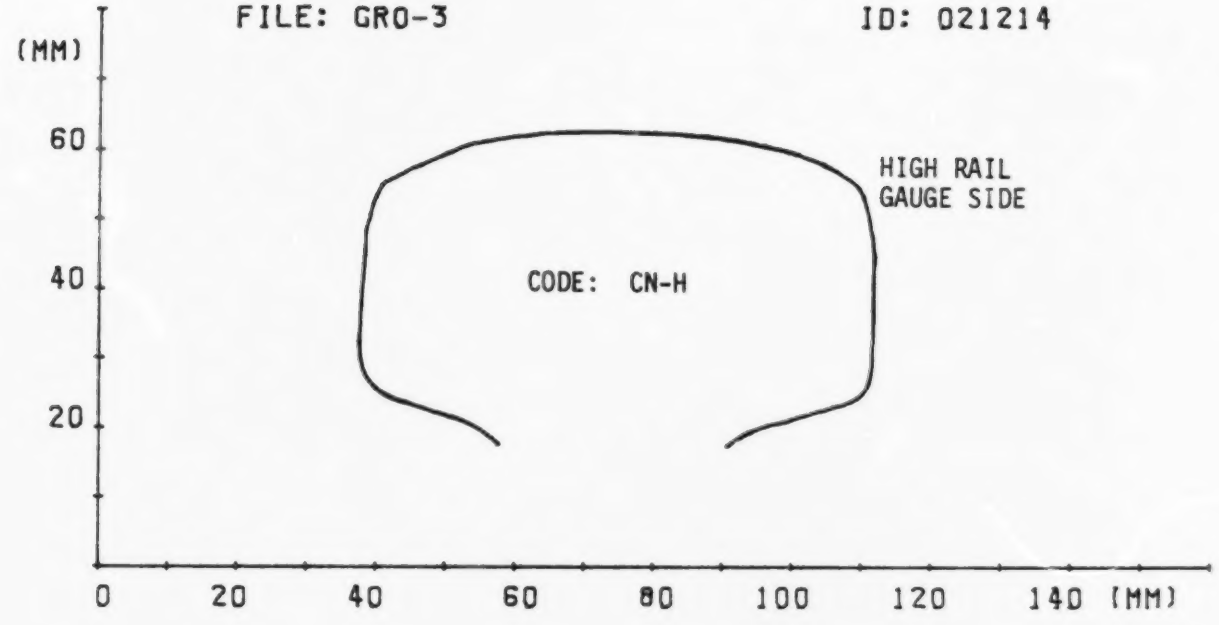
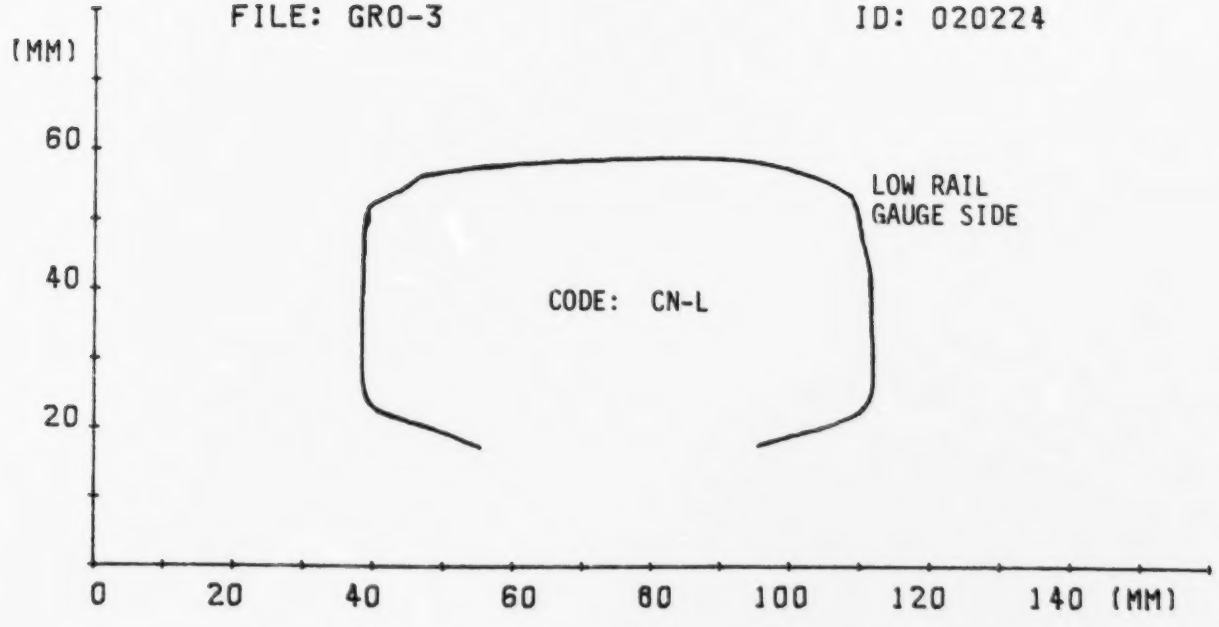
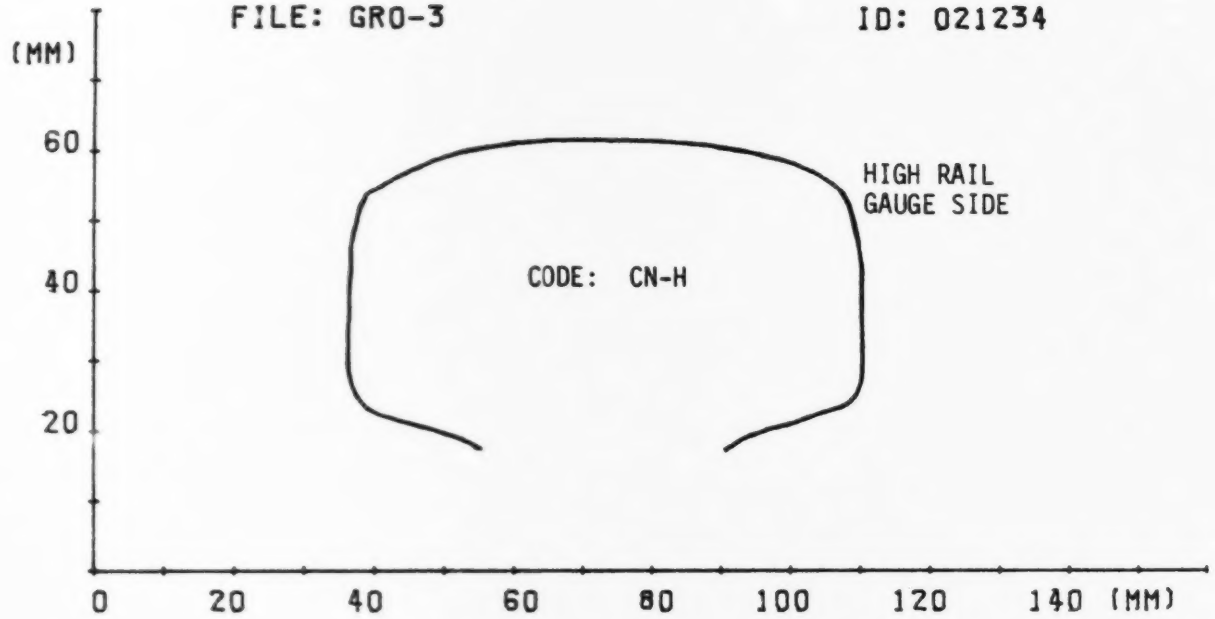
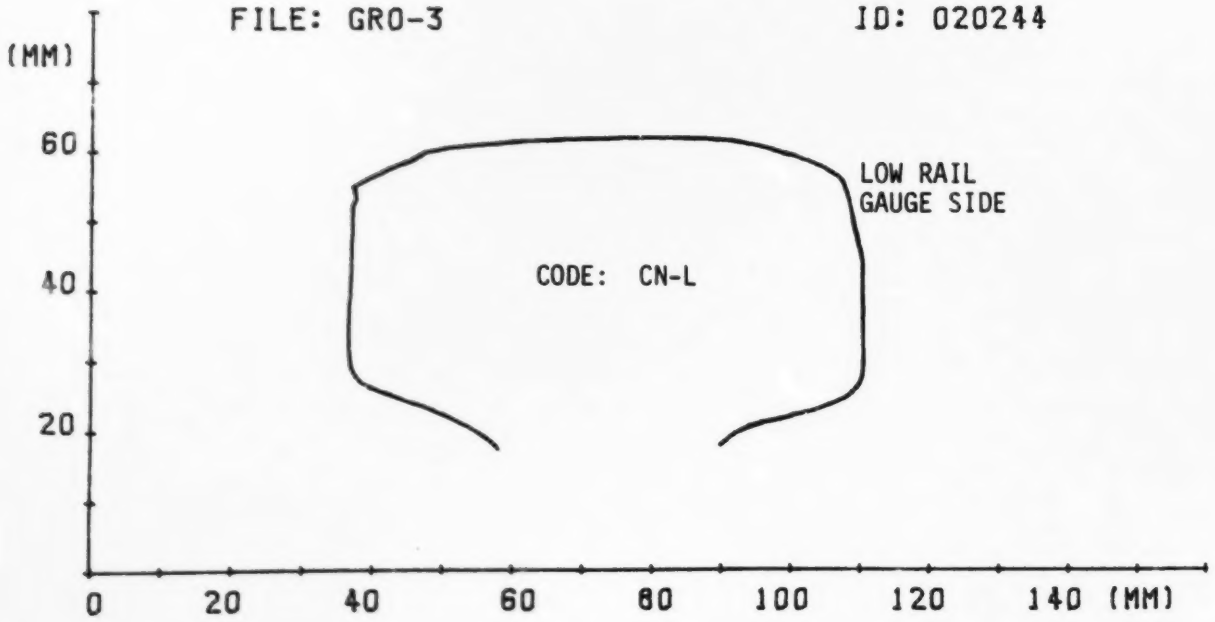


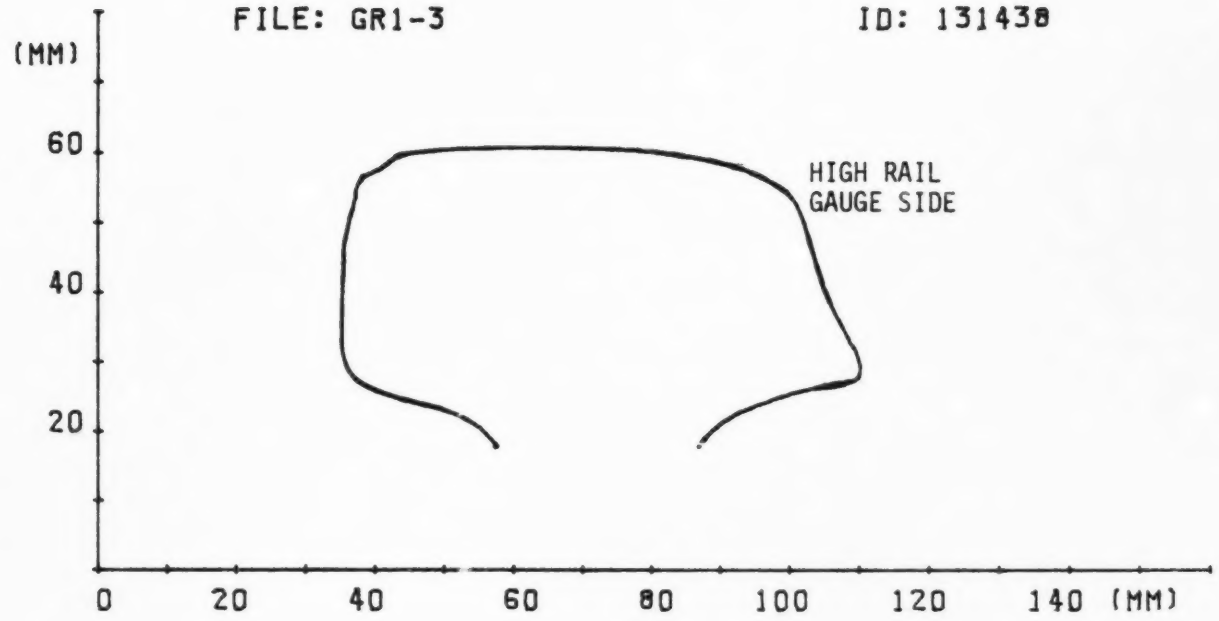


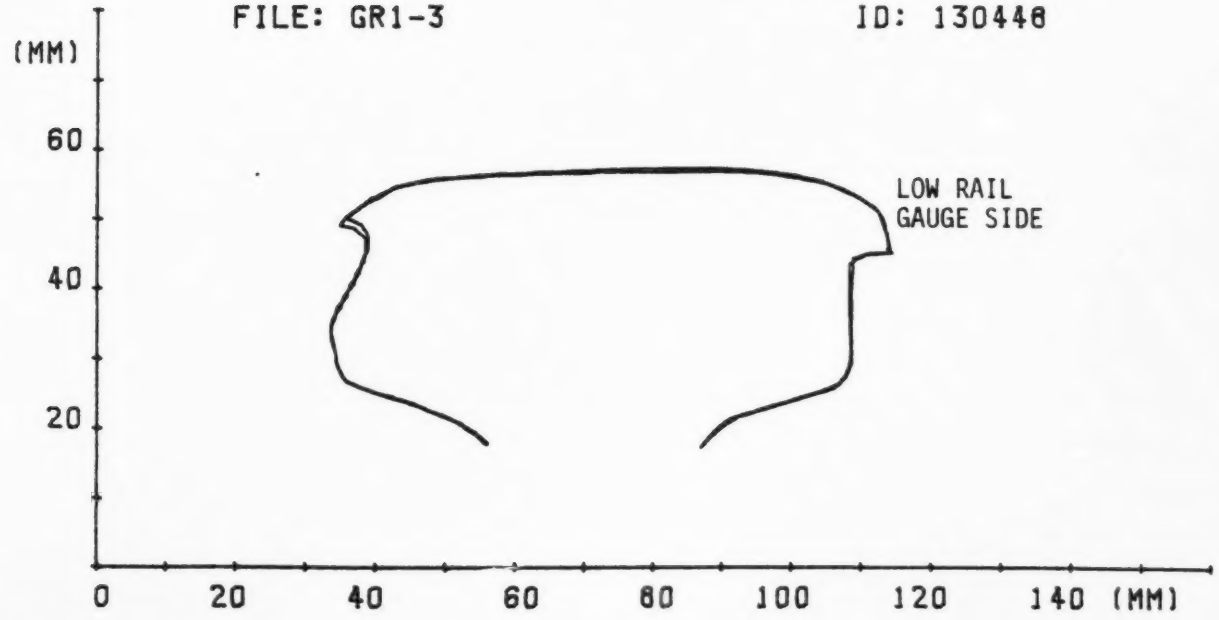
TEST SITE 2, 4 DEGREE CURVE AT MILEAGE 8.7



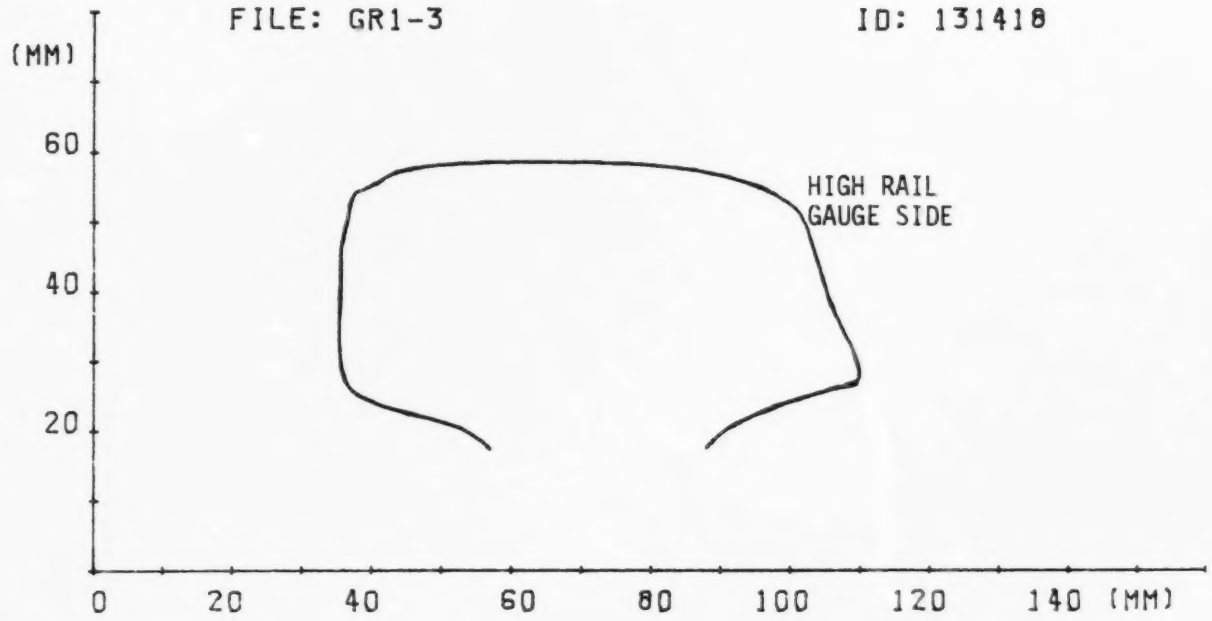


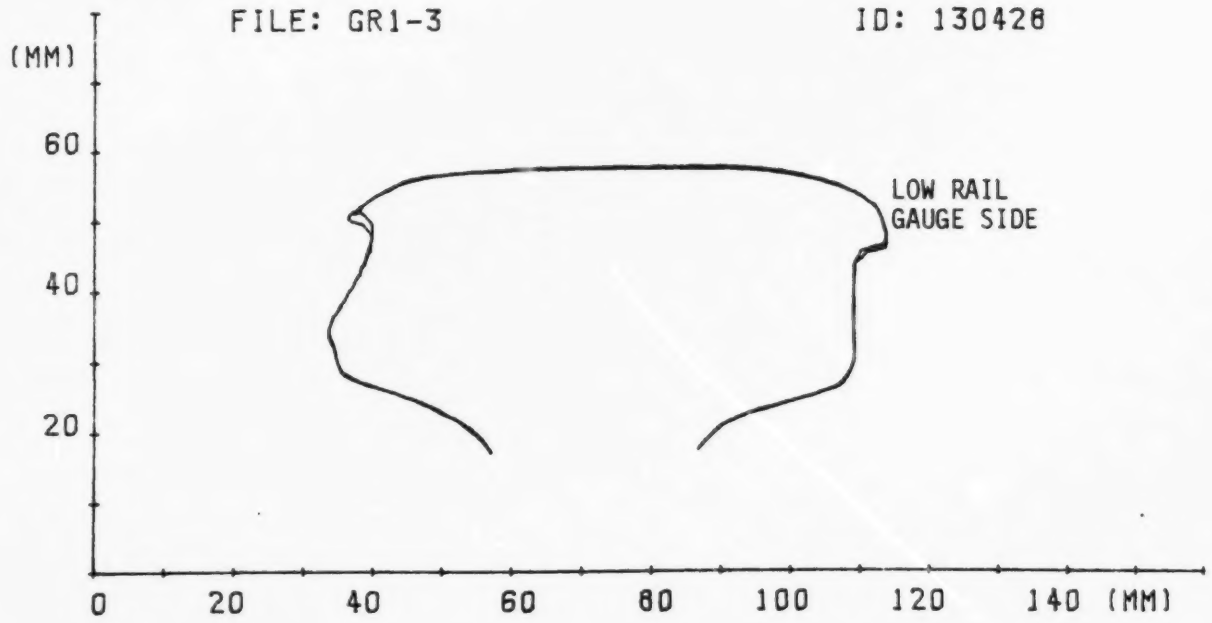
TEST SITE 2, 4 DEGREE CURVE AT MILEAGE 8.7





TEST SITE 13, 8 DEGREE CURVE AT MILEAGE 9.6

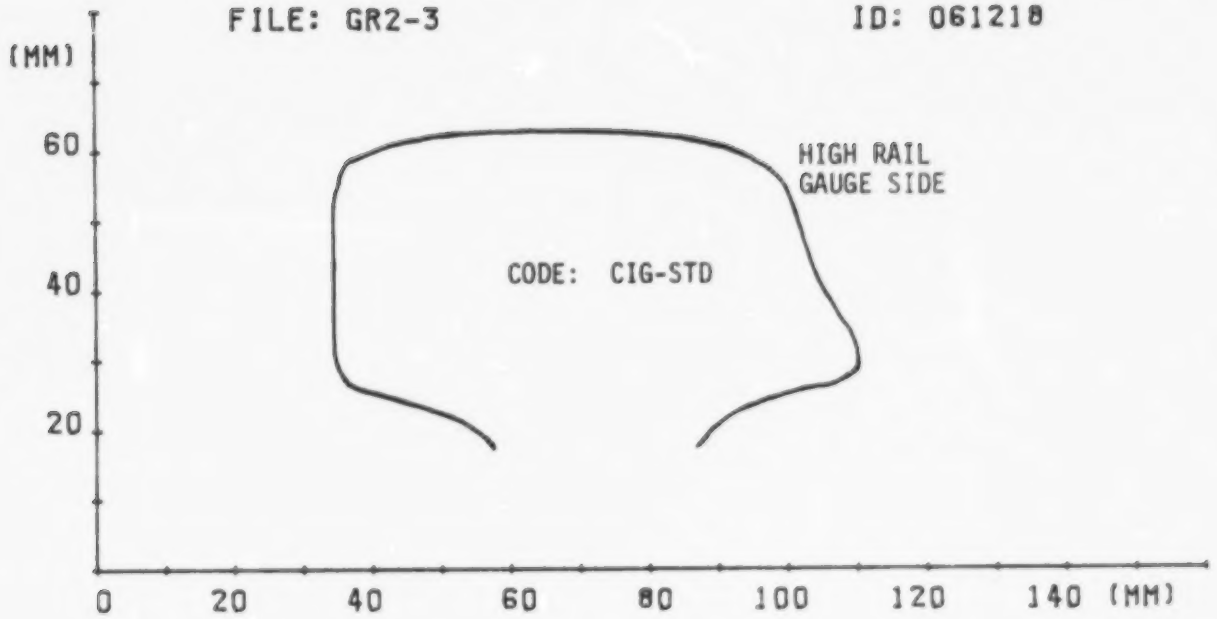


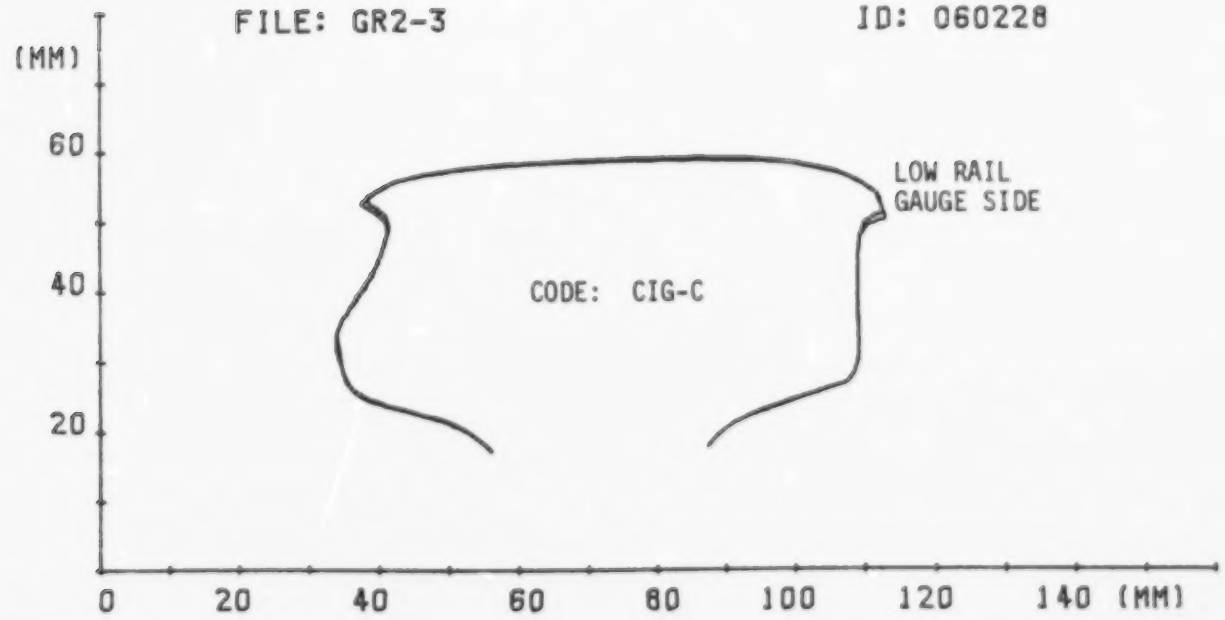


TEST SITE 13, 8 DEGREE CURVE AT MILEAGE 9.6

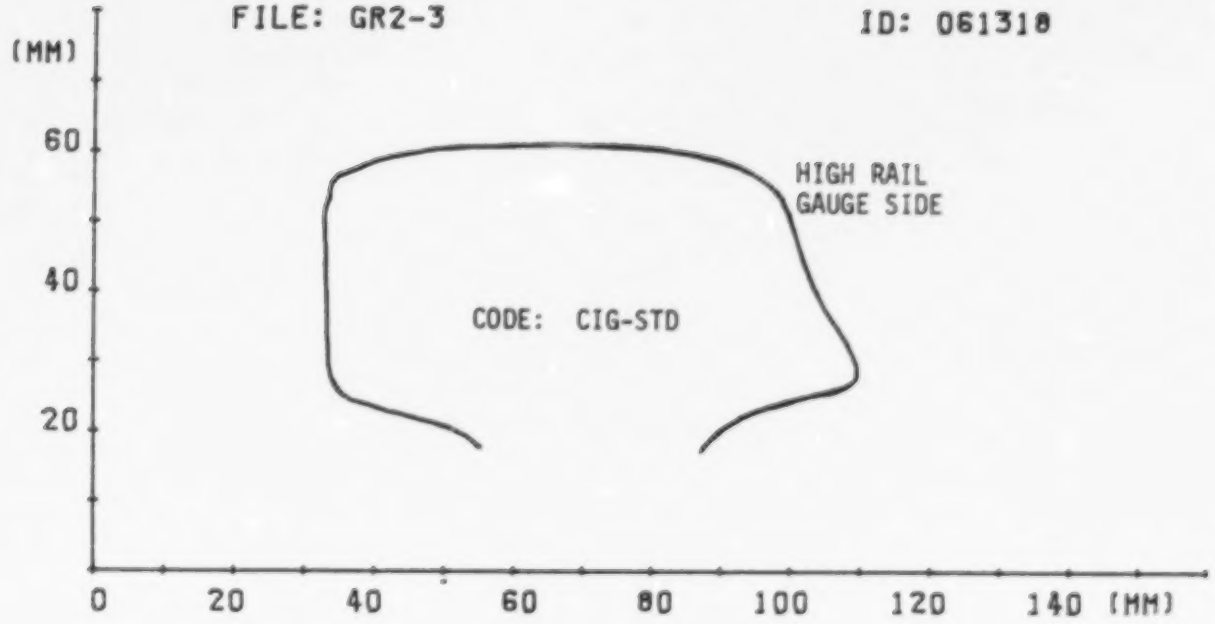
CIG-STD - Grinding for High Rail in 8° and 4° Curves

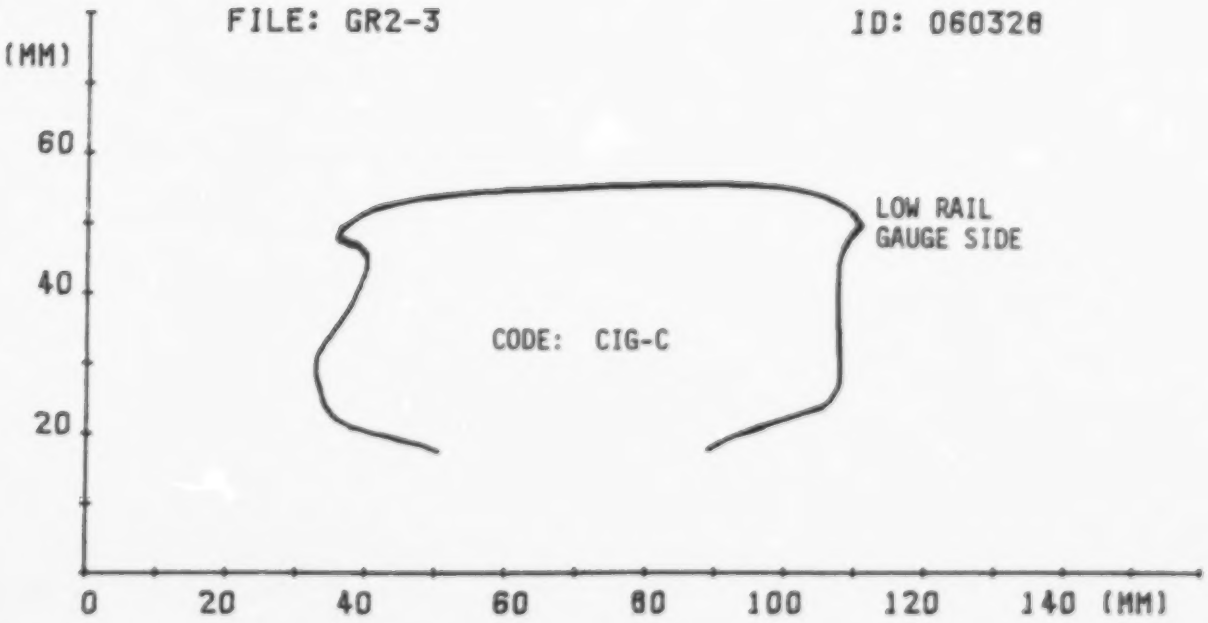
CIG-C - Grinding for Low Rail in 8° and 4° Curves



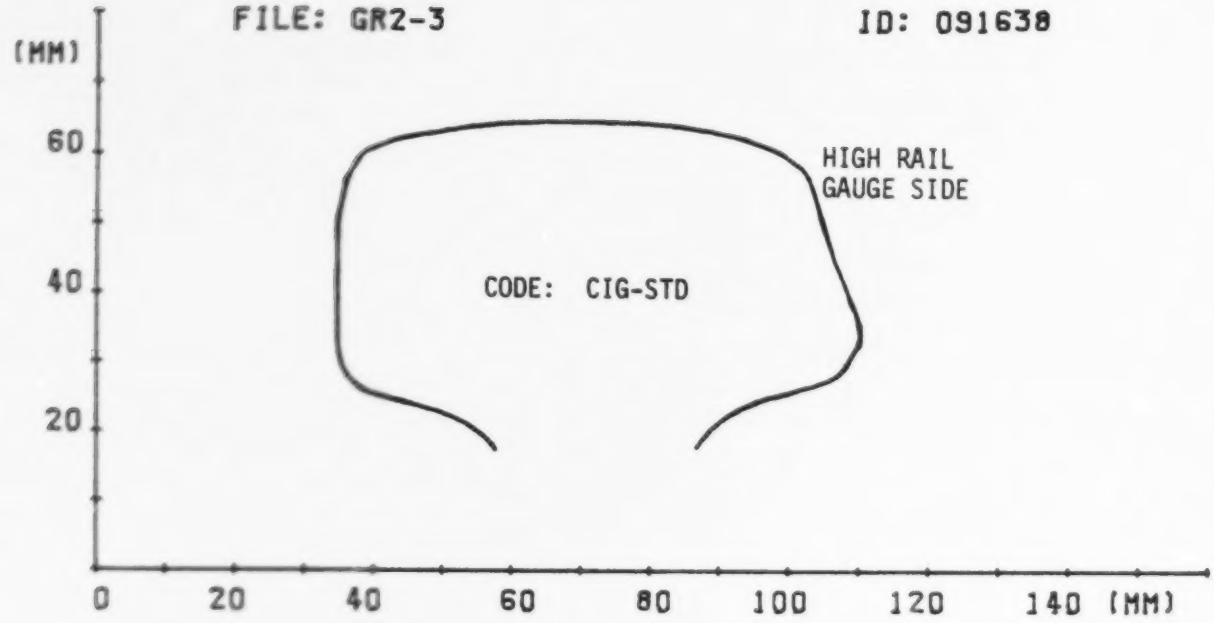


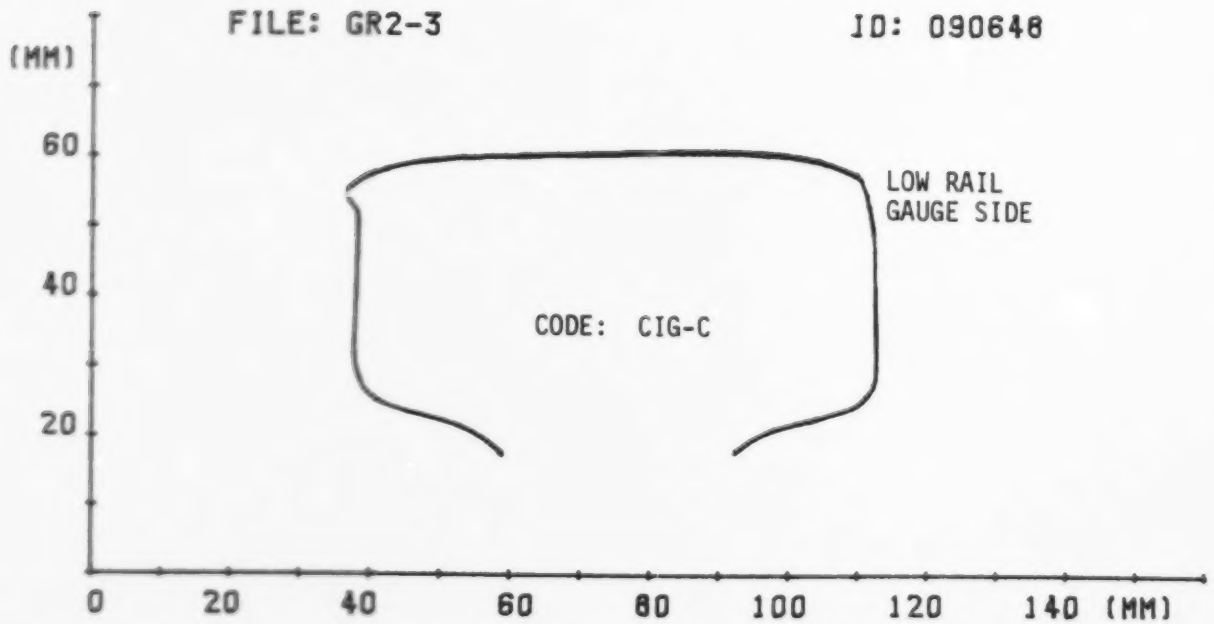
TEST SITE 6, 8 DEGREE CURVE, MILEAGE 10.6



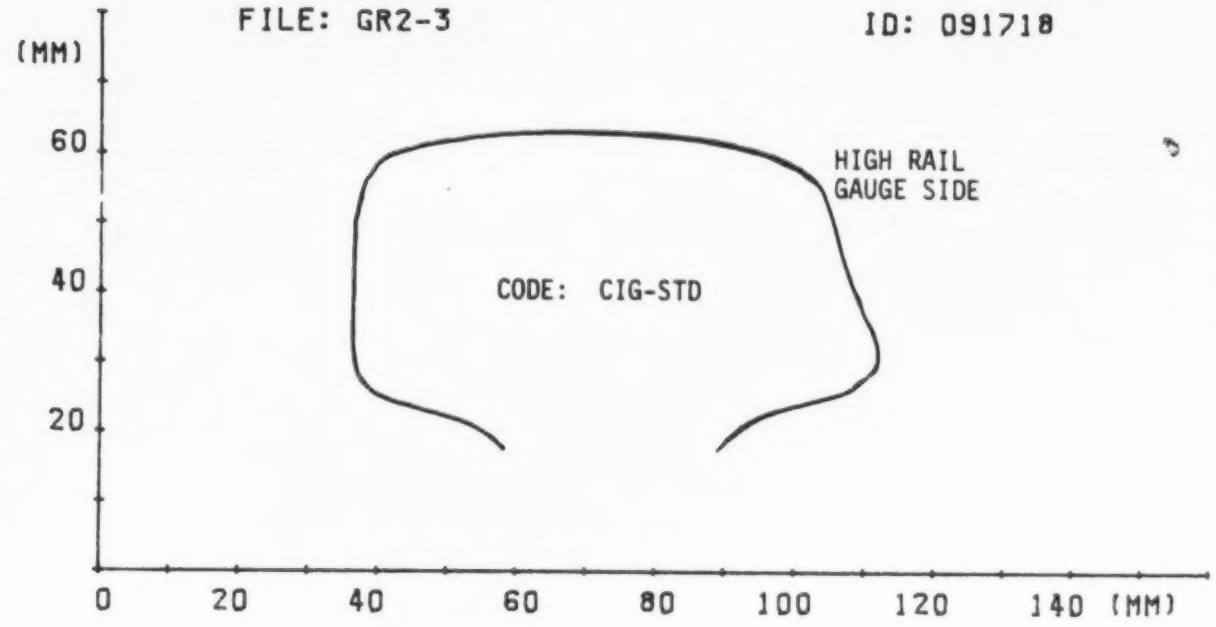


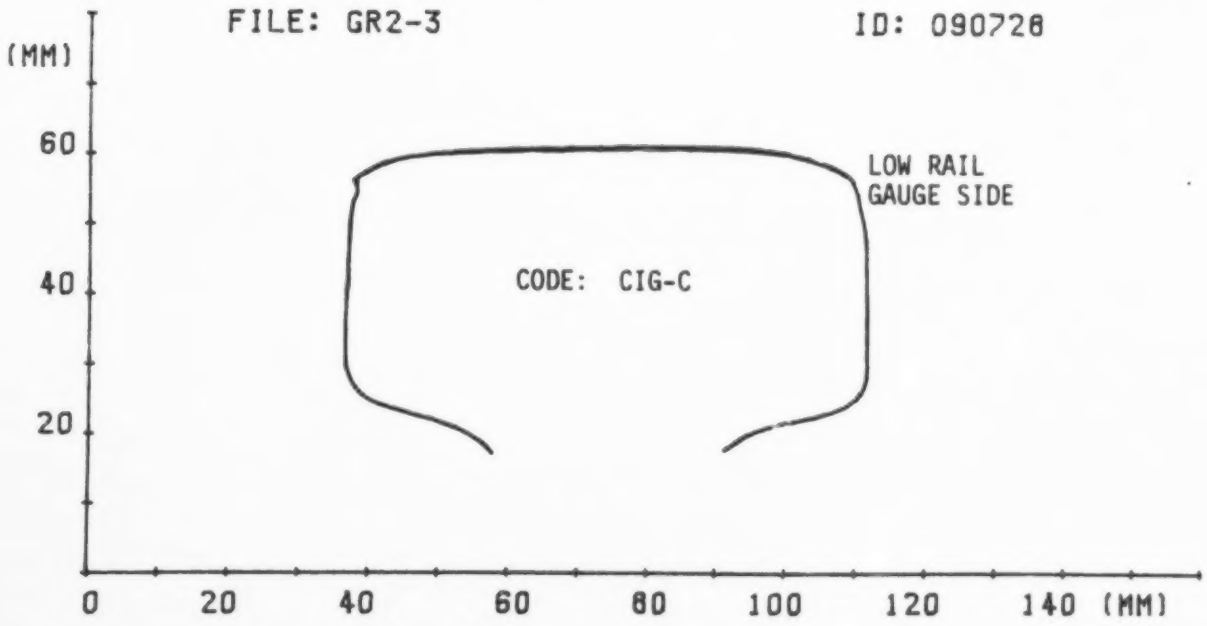
TEST SITE 6, 8 DEGREE CURVE, MILEAGE 10.6



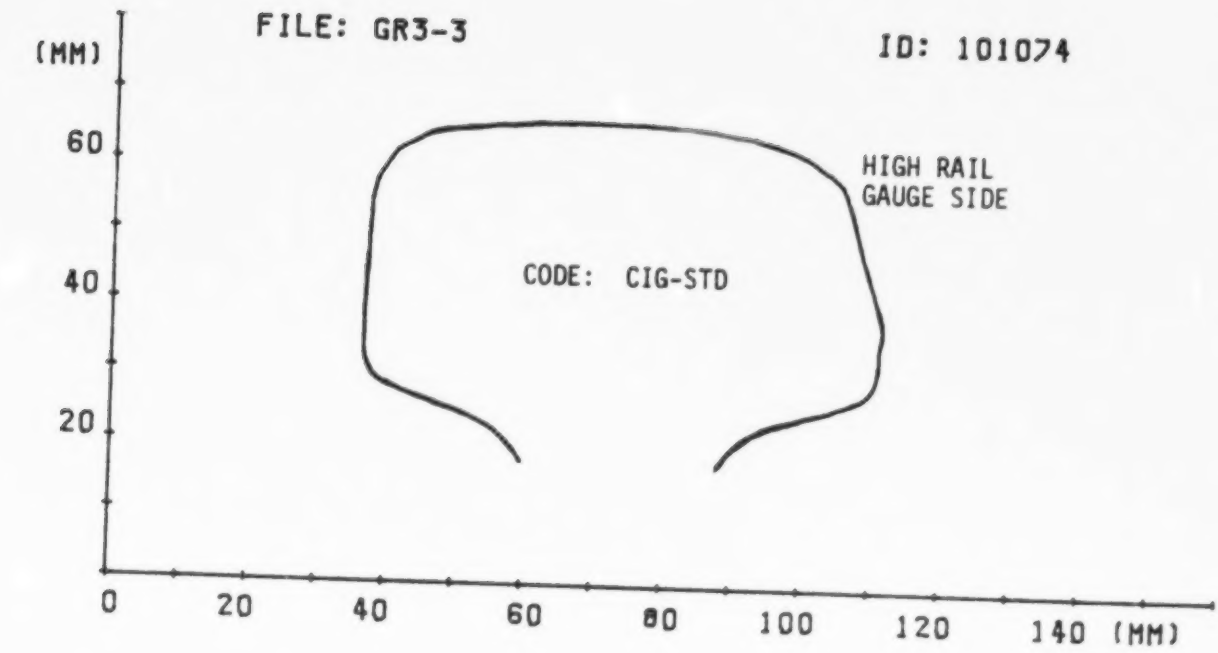


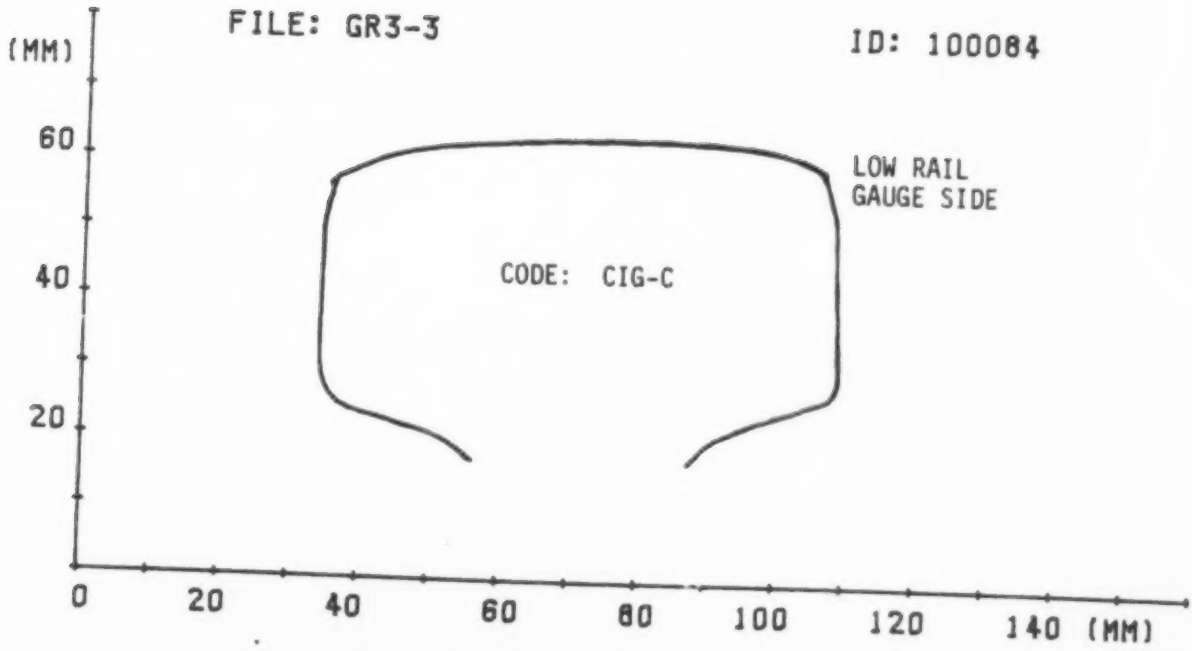
TEST SITE 9, 8 DEGREE CURVE AT MILEAGE 17.1



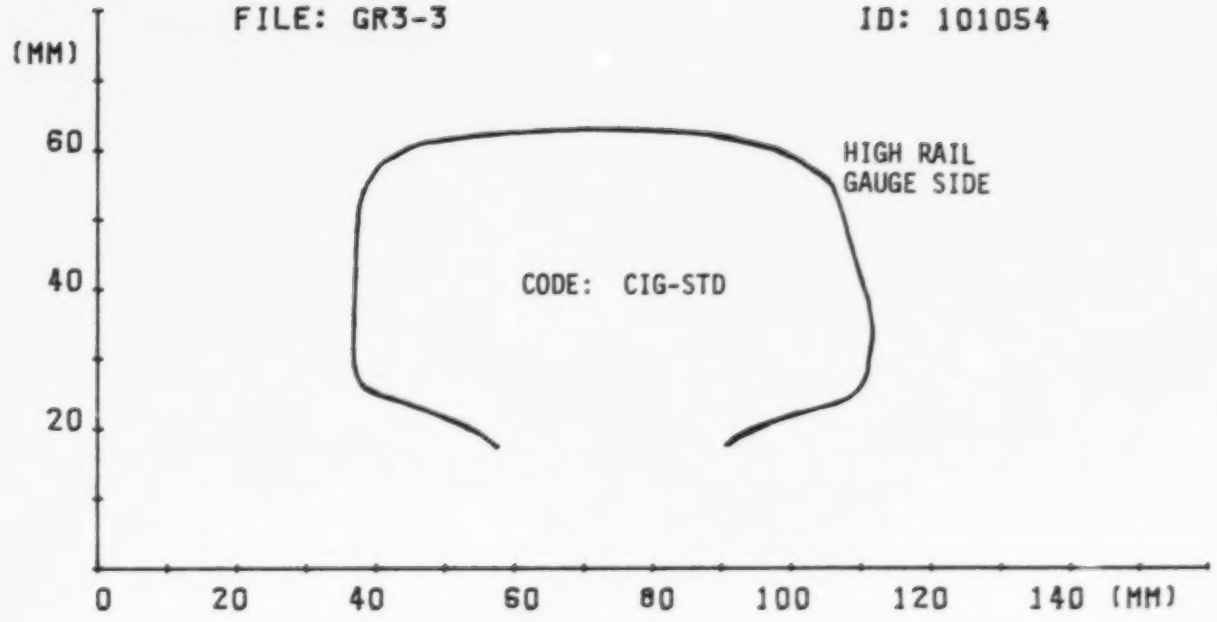


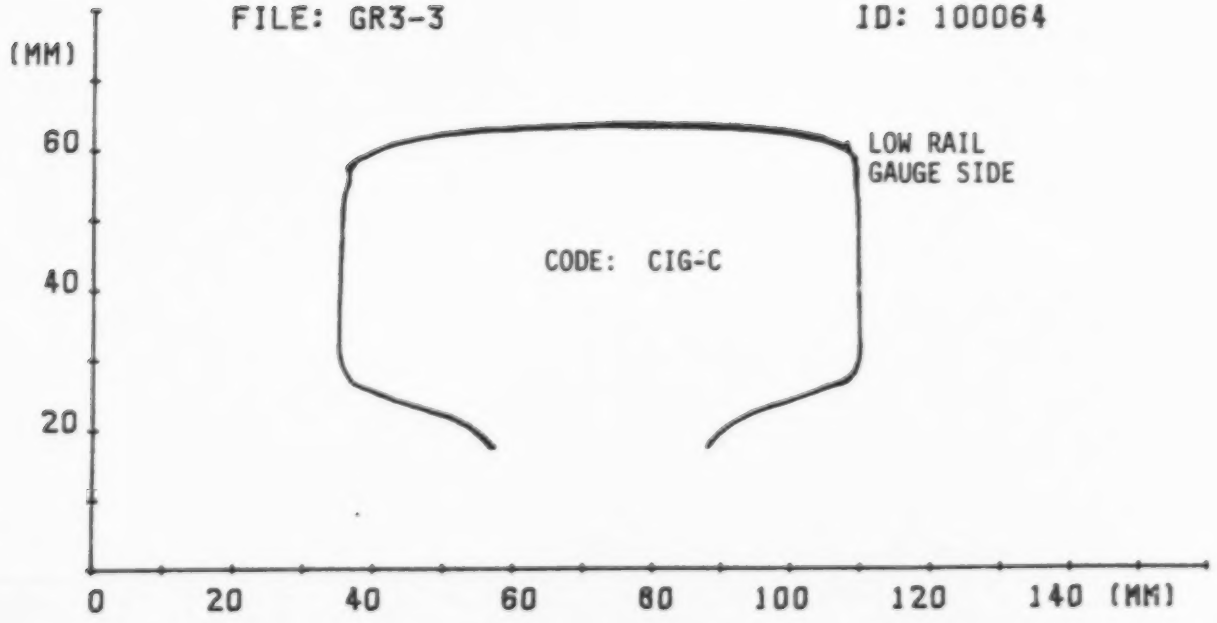
TEST SITE 9, 8 DEGREE CURVE AT MILEAGE 17.1



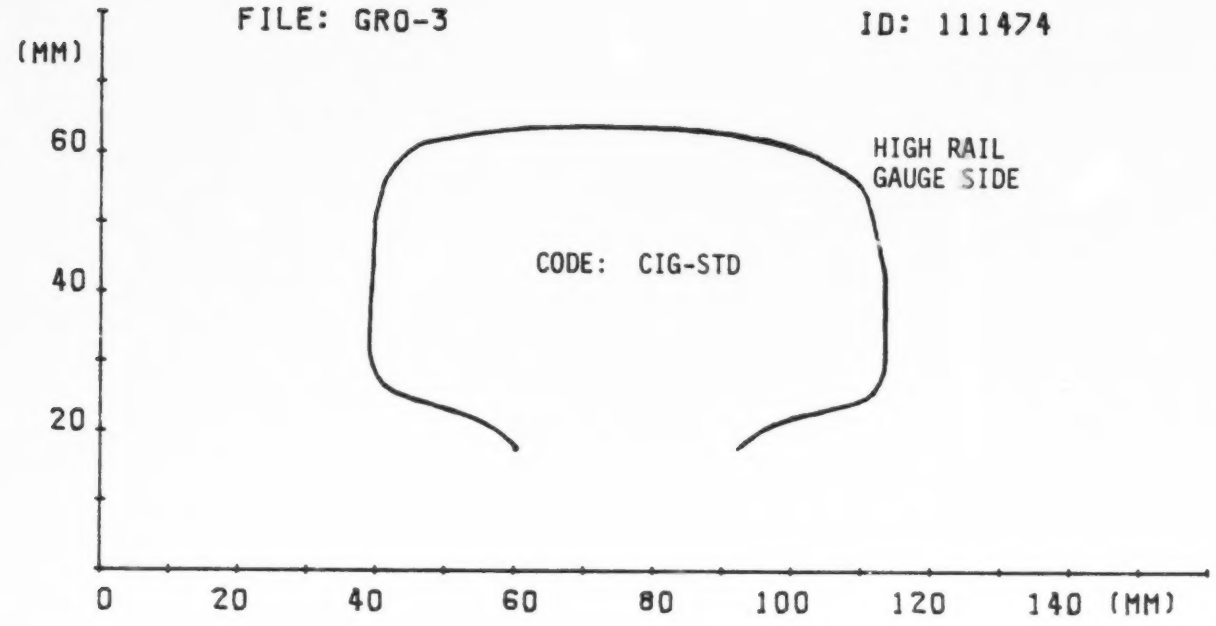


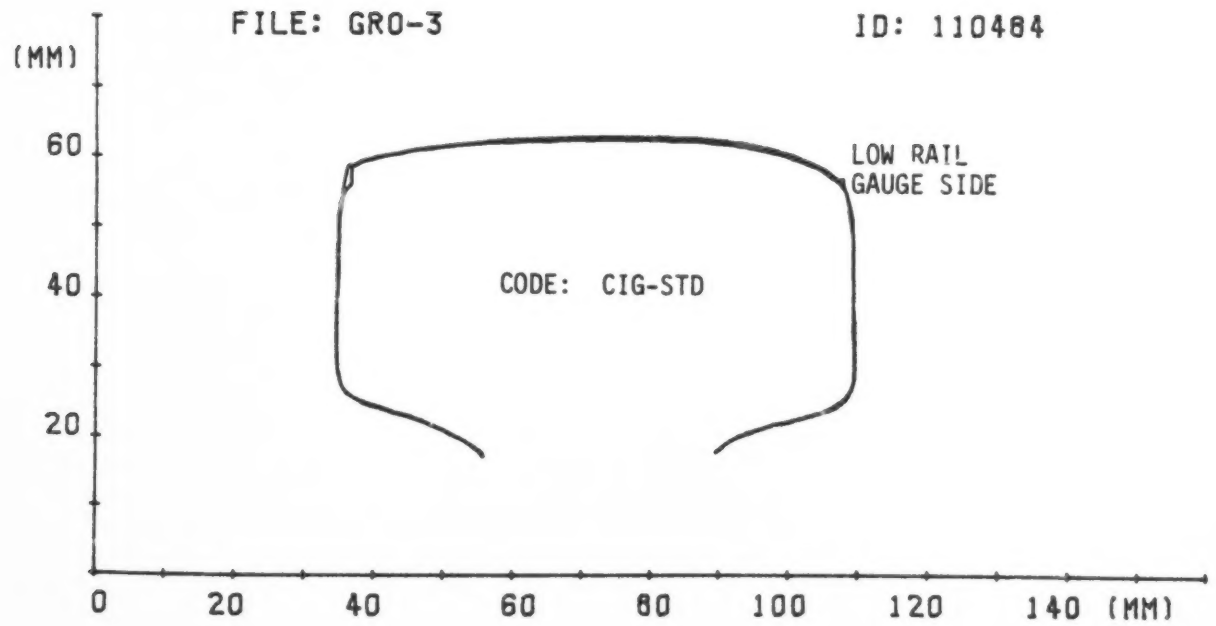
TEST SITE 10, 4 DEGREE CURVE AT MILEAGE 26.1



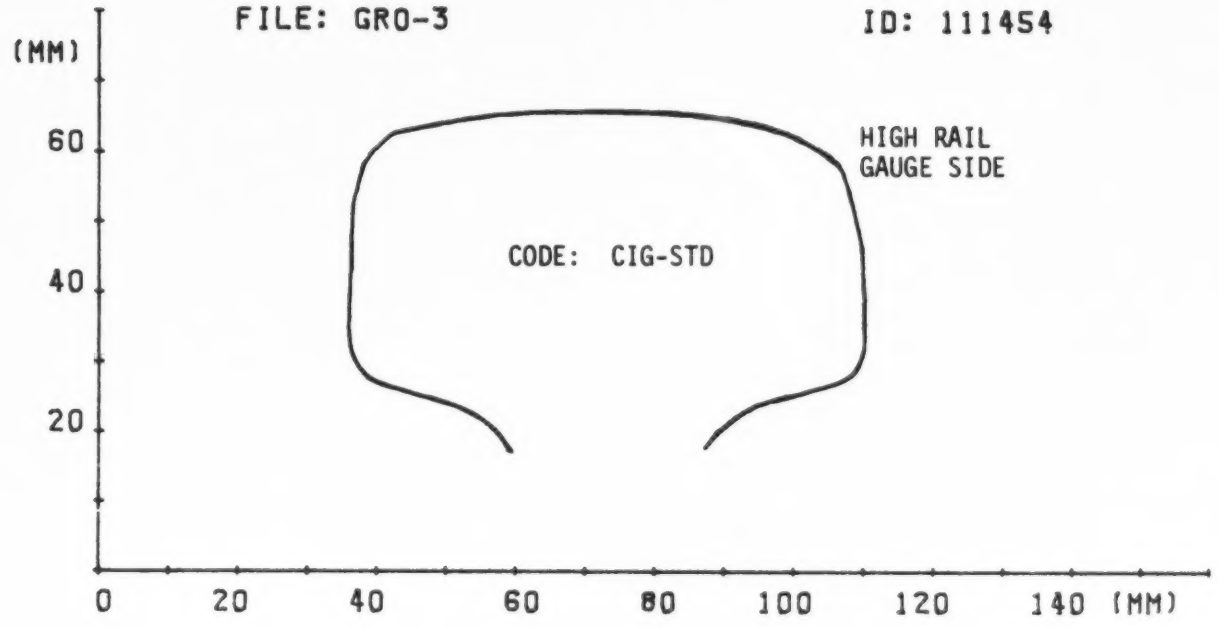


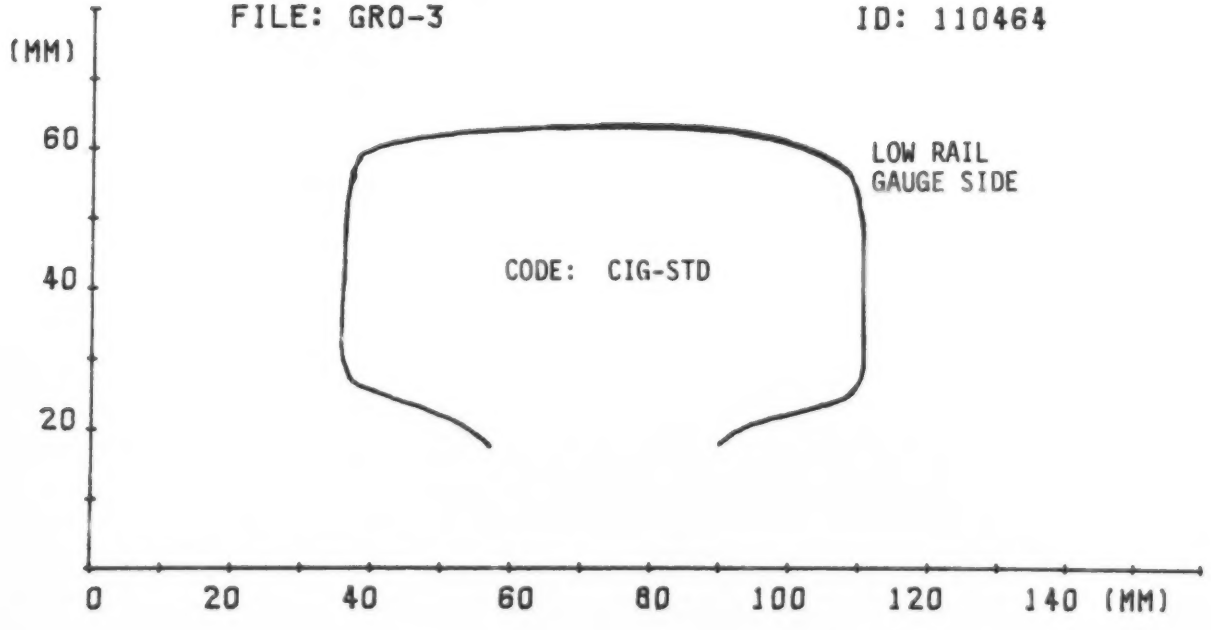
TEST SITE 10, 4 DEGREE CURVE, AT MILEAGE 26.1





TEST SITE 11, 4 DEGREE CURVE AT MILEAGE 27.1





TEST SITE 11, 4 DEGREE CURVE AT MILEAGE 27.1

POOR
QUALITY
ORIGINAL